

DECEMBER 1973 60 CENTS

Popular Science

THE **What's New** MAGAZINE

**Before You Buy:
A SHARP LOOK
AT THOSE NEW
ELECTRIC SHAVERS**

NEW CATALYTIC CARB
Cracks Gasoline into
Clean-Burning Gaseous Fuel

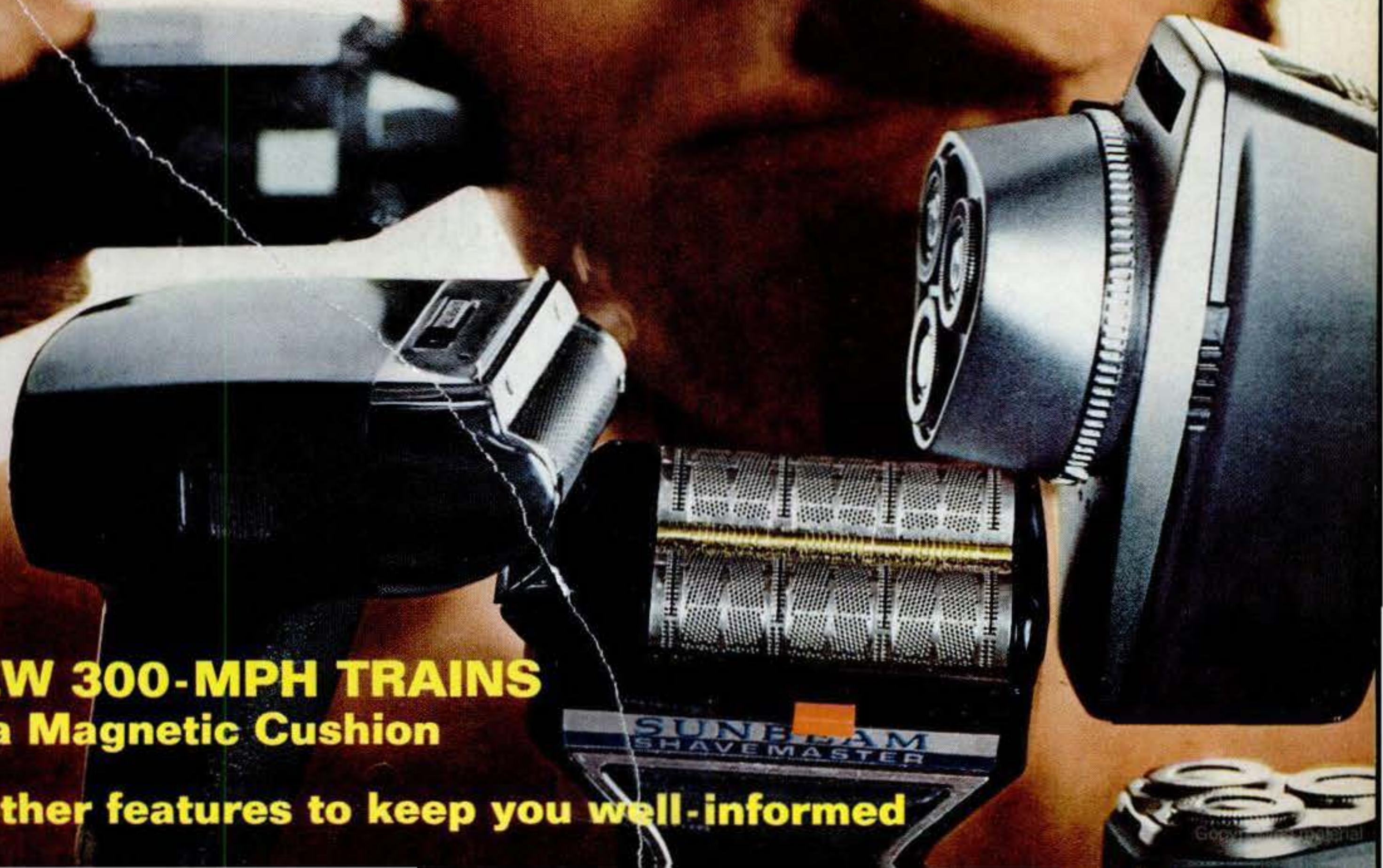
**How Pioneer 10's Clever
New Sensors Will Unveil
MYSTERIES OF THE
PLANET JUPITER**

EARTHQUAKES
Now Science Can
Predict When and
Where They'll Happen

**Testing Three
SUPERCARS**
What Are Their Secrets?

HOT NEW 300-MPH TRAINS
"Fly" on a Magnetic Cushion

Plus 37 other features to keep you well-informed





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King Size.
Long Size.

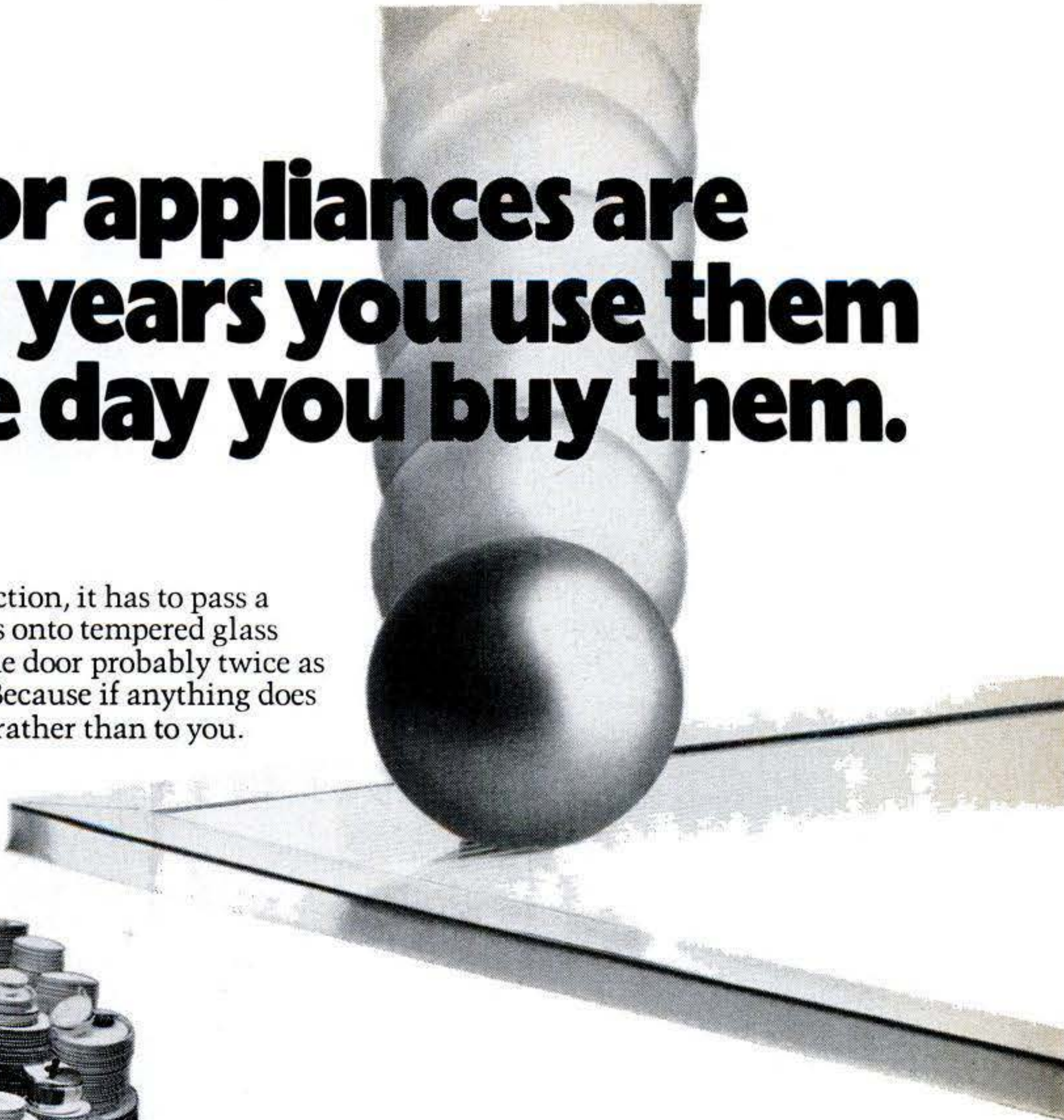
Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

King Size, 17 mg. "tar," 1.2 mg. nicotine;
Long Size, 18 mg. "tar," 1.3 mg. nicotine av. per cigarette, FTC. Report Feb. 73.

GE major appliances are built for the years you use them not just the day you buy them.

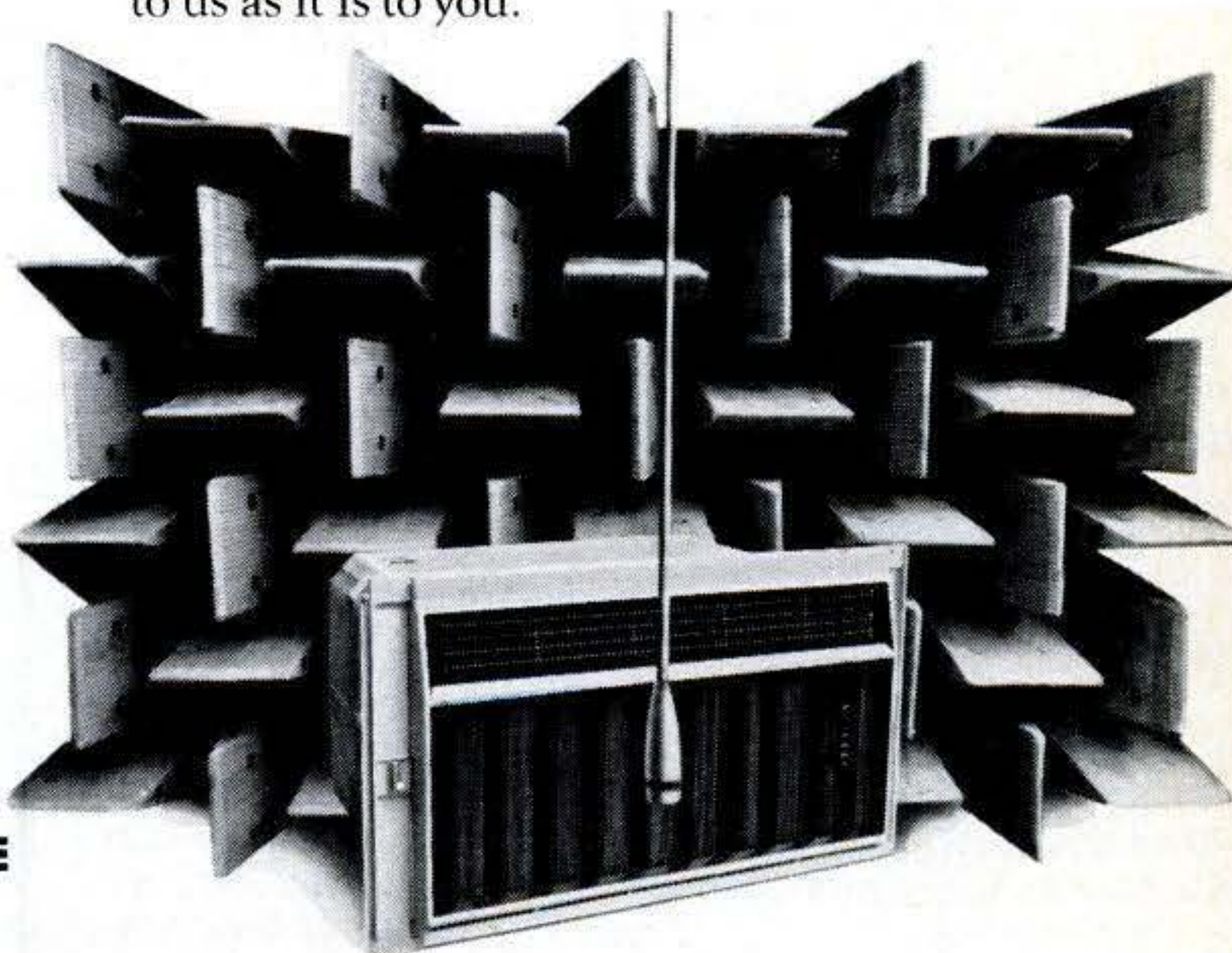
Product testing that's rougher than kids.

Before a major appliance goes into production, it has to pass a battery of torture tests. We drop steel balls onto tempered glass refrigerator shelves. We open and close the door probably twice as much as most people would in 20 years. Because if anything does go wrong, we try to have it happen to us, rather than to you.



A good appliance is built to be seen and not heard.

That's why we have sound absorption rooms where every sound can be isolated and identified. If we find any unwanted noise, we redesign the machine to eliminate or minimize it before we go into production. That's how we tested our Slumber Line air conditioners so they'd be ideal for bedroom use. In short, the quiet operation of a General Electric major appliance is as important to us as it is to you.



Imagine washing a load of dishes 11,000 times.

That's only one of the tests we give our dishwashers before they're approved for production. If it can stand up to this treatment in our factory, imagine how it will stand up in your home.

GE gives you Customer Care...Service Everywhere.™

This is our pledge that wherever you are or go in the U.S.A., you'll find a qualified General Electric serviceman nearby. Should you ever need him.



Good Service...another reason why GE is America's #1 major appliance value.

GENERAL  ELECTRIC

This One



JBHE-UKU-ZEFX

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Our First Look at Jupiter By Wernher von Braun **PAGE 70**

How we'll look at the huge planet close up as Pioneer 10 whizzes past.

PS Guide to the New Electric Shavers **PAGE 73**

Take a sharp look at 14 popular beard mowers that the PS test panel used.

New Catalytic Carb Gives Cleaner Exhaust **PAGE 76**

Fuel system from Siemens in Germany turns pollutants to harmless vapors.

Earthquakes: Now Science Can Predict When and Where They'll Happen **PAGE 78**

It may even be possible eventually to *control* quakes in danger areas.

How They're Getting Trains Off the Ground **PAGE 94**

Magnetic levitation (maglev) will revolutionize ground transport.

COVER PHOTO BY SHIG IKEDA

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EDITORIAL OFFICES

380 Madison Avenue, New York, N.Y. 10017

Return postage must accompany all manu-
scripts submitted. We cannot be responsible
for the loss of manuscripts or photos.

Published monthly by

TIMES MIRROR MAGAZINES, INC.

380 Madison Avenue, New York, N.Y. 10017

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212-687-3000; Chicago: 401 N. Michigan Ave.

(60611), Tel. 312-527-0550; Detroit: 1716

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• *All subscription adjustments:* Write to Robert

Harlan, Popular Science, P.O. Box 2871, Boulder,

Colo. 80302. For change of address allow six

weeks; please give both old and new addresses.

Notices of undelivered copies (Form 3579) to

Mr. Harlan. • Second-class postage paid at New

York, N.Y., and at additional mailing offices.

Entered as second-class matter at the Post Office

Department, Canada. Printed in U.S.A.

Microfilm editions are available from Univer-

sity Microfilms, Ann Arbor, Mich. 48106.

Mechanics and Handicraft® Popular Science®

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What's New DIGEST

A PICTURE ROUNDUP OF NEW
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WHILE YOU'RE WARMING UP YOUR CAR, YOU COULD BE WEARING OUT YOUR ENGINE.

You've probably heard many times that you should warm up your car engine a little before driving off, but a lot of people have a tendency to overdo it.

They let the car run while they're having their morning coffee and figure that when the seat is warm enough to sit on, the engine is warm enough to start traveling.

It's a very comfortable misleading myth. And we'd like to explain why.

When you start cold, extra fuel is delivered to the cylinders because the automatic choke provides a rich mixture of gasoline and air.

The extra gasoline washes some of the protective oil off the cylinder walls and piston rings. As this continues to happen, you get more and more wear on these parts. And the oil in your crankcase is diluted with gasoline.

The right idea is to get the engine up to a normal operating temperature as quickly as possible, after a brief idle period to assure that engine oil pressure is normalized. The automatic choke will then turn off and the engine will get to a normal, leaner mixture sooner.

This getting to a normal operating temperature is best done by driving. Not by standing still.

Of course, there are other ways of minimizing wear. One of them is by choosing the proper grade of a high-quality motor oil to put in your crankcase.

We at Gulf take great pride in the quality of motor oils we produce. In fact, our top line oils are named Gulfpride. If you stop at one of our Gulf dealers, he'll be happy to tell you about them or anything else you'd like to ask about your car.

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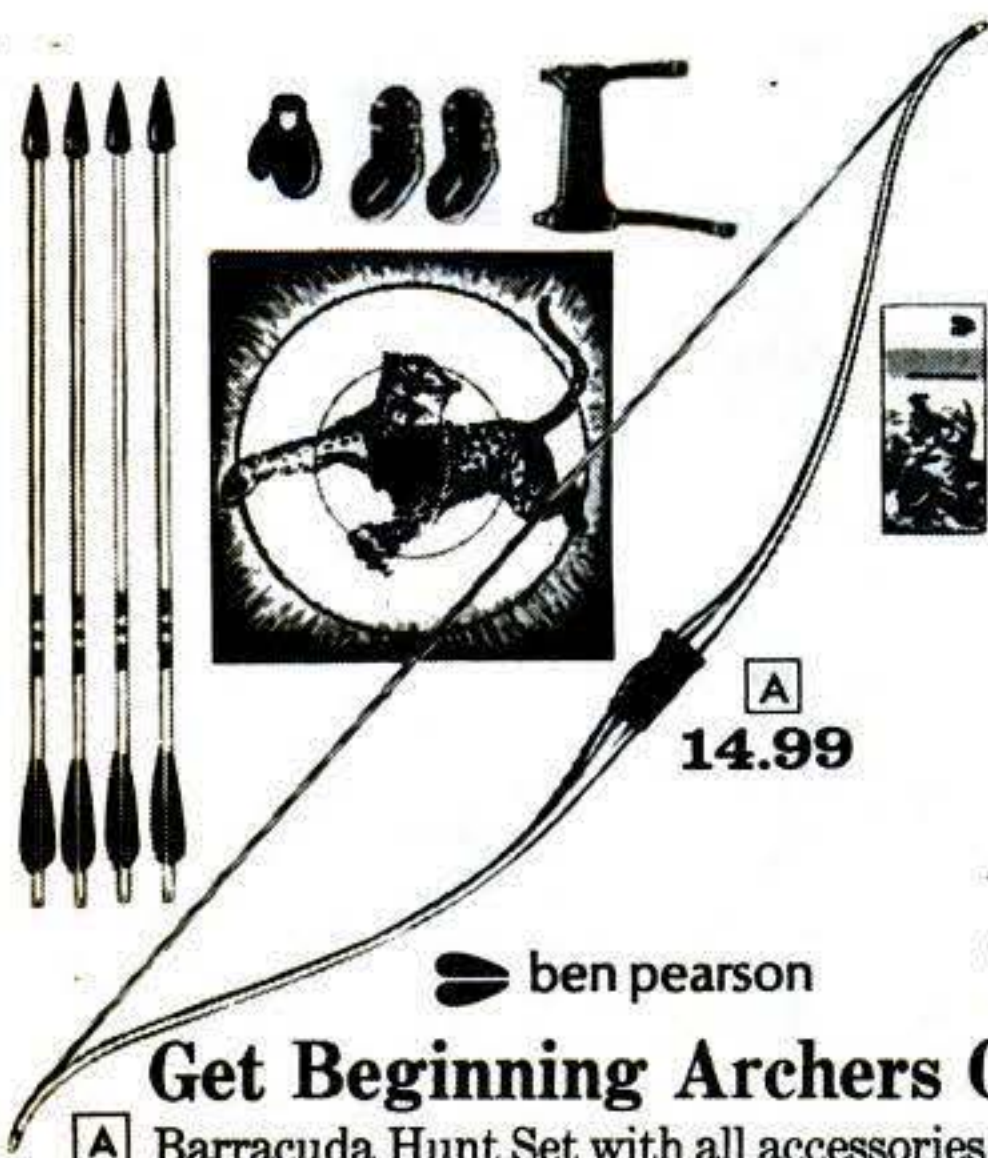
Santa's Preview



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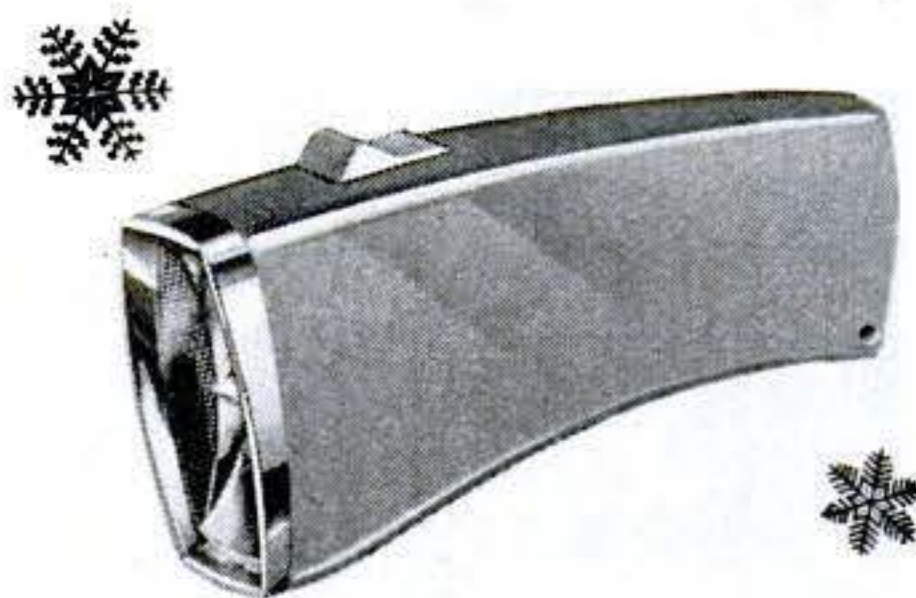
Famous Deluxe Cherry Wood Gun Rack

D Unique locking bar lets you display guns safely. 4-place felt-lined grooves, locking drawer. Hand-rubbed walnut finish. **10.88**



Jason Empire Sport Binoculars

7X35 wide-angle lens shows you 40% more area. Center focus, coated optics. **21.88**
7X50 model brings objects 7 times closer. Big 372-ft. field of view. Case. **27.99**



MALLORY Disposable Light

This handy little pocket flashlight casts a powerful 250-ft. beam into the darkness. No parts to fool with, just replace it when power runs out. **99c**



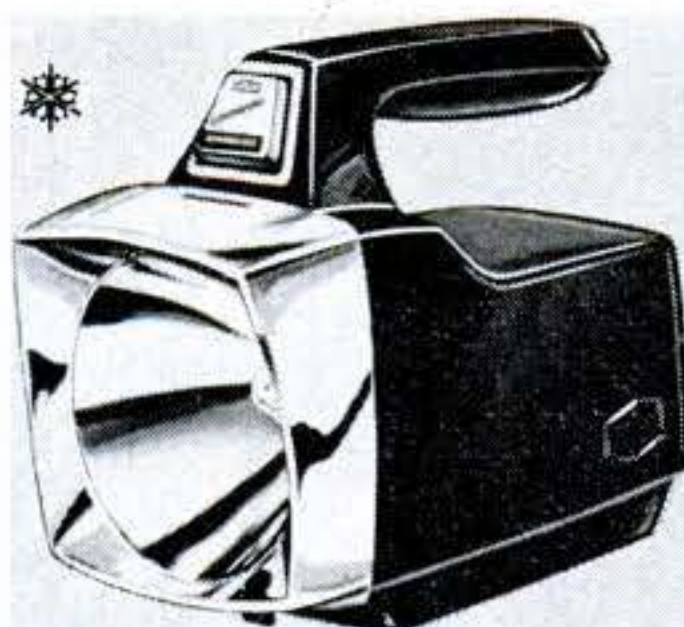
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Joe Frazier gloves, 12 to adult. **9.88**



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When identified by a factory-sealed "M" tag, Minolta 35mm reflex cameras are warranted by Minolta Corp. against defects in workmanship and materials for two years from date of purchase, excluding user-inflicted damage. The camera will be serviced at no charge provided it is returned within the warranty period, postpaid, securely packaged, including \$2.00 for mailing, handling and insurance.

"To the tall green woods
came I
To his arms to love,
to lie . . ."
Anne Wickham

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is wilderness.



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PS Readers Talk Back

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Heating pool water



After installing Solarator, the "Black Mattress That Puts Btu's in Your Pool" [June] on a wood platform, 45 degrees to the sun at one p.m., we found that water going through the unit was six degrees warmer than pool water. The instructions say, "one to two gallons per minute, no more." We adjusted the flow to a gallon per minute. Results: 60 gallons per hour, six degrees F warmer. However, in an 18,000-gallon pool with 10 hours of sun at the right angle, Solarator would increase the heating of the water only 1/5 degree. (The temperature in our pool stays between 75-80 degrees without any heater.) We'd need five units to increase the pool temperature one degree. We returned the Solarator.

JOHN H. JANSINGH, Jenison, Mich.

Author Richard Day replies: "Your figures are correct as far as they go. But you stopped computing too soon. That's one-fifth degree per day, every sunny day. It's cumulative. Even in a big pool like yours, in a month your low-level 3000-Btu solar output would provide more than a five-degree temperature rise and no fuel bill. The professors who developed the unit recommend one unit for every 10,000 gallons of pool capacity. Think you returned your unit without giving it a fair trial."

Protecting inventions

The article "A New Program to Protect Your Invention" [Sept.] states that the old tried-and-true method of mailing yourself a registered letter isn't too much patent protection. I agree with this. But there are other ways to prove date of conception. You can make tape recordings relative to the invention, take photos and home movies with the day's newspaper prominently displayed in them to establish the dates of the photos.

STEVE CONKOVICH, Allentown, Pa.

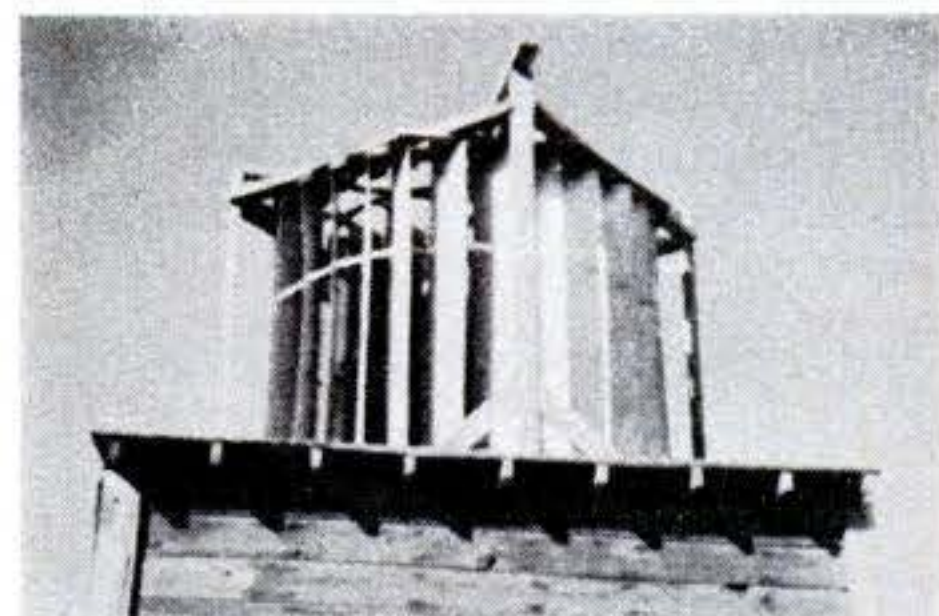
. . . As a person with a few simple inventions, I abhor the struggle necessary to obtain a patent. I view the Patent Office itself as an invention created to secure each inventor his constitutional rights. Yet the efficiency with which this is done cannot be adequately measured because inventors are discouraged by the costs and nature of the system.

Perhaps the new program finds little use because the inventors know the protection of their inventions depends on a multitude of factors; money to find and hire the patent attorneys to do battle in the Patent Office, money to pay the fees and searches to secure the patent papers, money to hire the lawyers to protect the patent in the courts from those who are financially stronger. Patent justice, like any other form of justice, costs money and may take years to secure, if ever.

FRANK PRAVDA, Stillwater, N.Y.

Reader's wind turbine

Congratulations for your outstanding continuing coverage of wind power as an alternate source of energy [Nov. '72; June and Sept. '73 What's News]. I'm enclosing a pho-



tograph of a vertical wind turbine I've been using for ten years to pump my water supply. The unit has been entirely trouble-free: the only attention given it has been to grease the bearings twice since installation. The outside vanes are stationary and direct the wind to apply direct thrust to the rotor with no back pressure. The maximum speed is limited by a hydraulic governor to prevent damage from centrifugal force in high winds.

C. L. SWETT, Winnemucca, Nev.

Hybrid-flywheel car

Mr. Lindsley's article "Hybrid Car: Part-Time Engine + Part-Time Flywheel = Full-Time Transportation" [Aug.] was excellent and provided much-needed visibility to a practical automobile-propulsion sys-

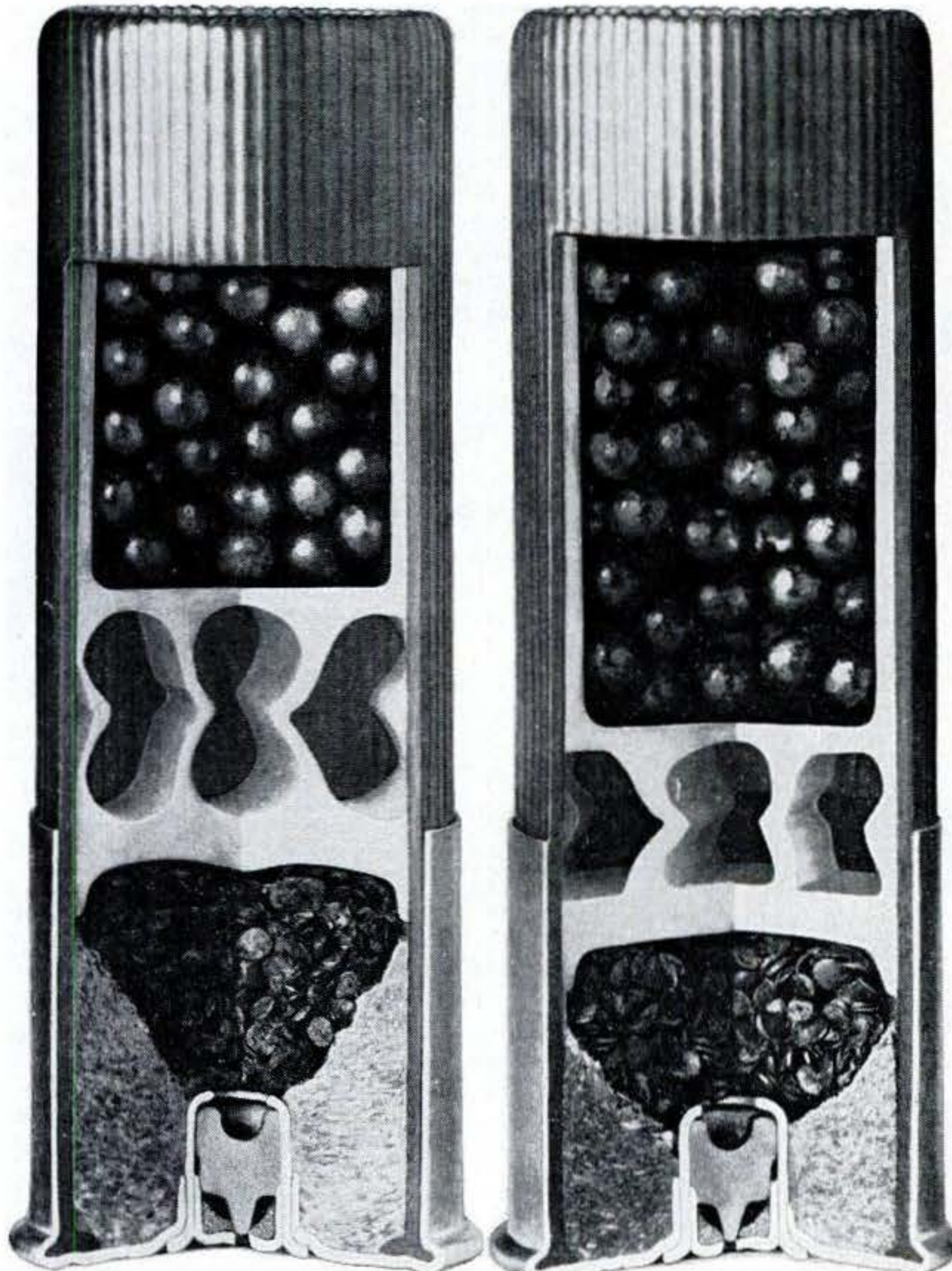
Continued

Want magnum performance from your standard 2¾ inch chambered shotgun?

What you get out of your shotgun depends on what you put into it. The shell on the left is a standard 2¾" long-range load. The shell on the right is a 2¾" magnum load (we call it our "baby magnum"), which delivers more pellets and a denser pattern at longer ranges. Both shells fit all standard 2¾" chambered shotguns.

Here's what a baby magnum can do for you: When you load up with Remington 2¾" magnum shells, you're putting in approximately 20% more shot than that carried in standard 2¾" shells. For example, 12 gauge baby mags carry 39 more pellets of #4 shot than standard field loads. (See chart below showing average pellet count.)

You waterfowlers can appreciate what a difference this can make. More shot, of course, means a denser pattern at the point of impact, and that's when the baby magnum earns its keep. How many times have all of us hunters sat in blinds hoping the geese would fly a little lower or ducks would pass closer? The standard-length magnum will increase your effective range by at least ten yards, and that can often mean the difference between a successful hunt and being skunked. Pellet count and pattern density are critical to your success when 40-yard shots are common and will help in reducing cripples, too.



Standard 2¾" 12 Ga. load

Baby magnum 2¾" 12 Ga. load

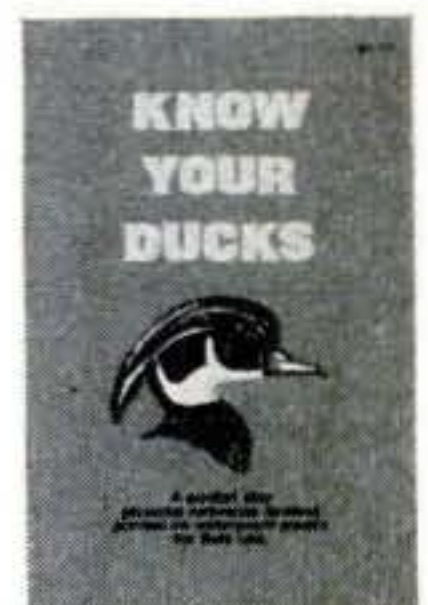
five more grains of a slower-burning powder, which provides the necessary power to drive the heavier loads while maintaining sufficient chamber pressure.

Baby magnums are available in 12, 16 and 20 gauge and in a variety of shot sizes as well. (See chart below.) The 12 gauge 2¾" magnum and most other Remington shotgun shells are loaded with our famous "Power Piston" one-piece wad to help you get all the power you pay for. By helping to reduce pellet distortion, the "Power Piston" wad actually puts more shot in your pattern than other wads, and that will improve any hunter's chances. A specially designed plastic shot protector is used in 16 and 20 gauge baby magnums to allow for maximum pellet count and weight.

Now, doesn't it make sense to carry a supply of baby magnums the next time you go hunting? They're not only an excellent selection for waterfowl, but are recommended for pheasants, big western grouse and the wily wild turkey. Baby magnums are real handy when shooting through heavy foliage, and if you tote a side by side or over and under to the field, a wise hunter will keep one in the choked barrel for that long second shot.

12 Ga. Shot Size	# Pellets per Ounce	Standard 2¾" 1¼ oz.	Baby Magnum 2¾" 1½ oz.	Pellet Increase	% Inc.
#2	87	109	130	21	19.2
#4	134	168	207	39	23.2
#6	221	276	331	55	19.9

Baby Magnum Gauges	Shell Length Inches	Ounces of Shot	Shot Sizes
12	2¾	1½	2, 4, 5, 6
16	2¾	1¼	2, 4, 6
20	2¾	1⅜	4, 6, 7½



Get "Know Your Ducks", a pocket-size reference booklet with illustrations of the 17 ducks most frequently found in the North American flyways. Printed on waterproof plastic.

Regularly a \$2.00 value, it's yours now for only \$1.00 and two box tops from any Remington "Express" or "Shur Shot" shotgun shell boxes when you send them to Remington Arms Company, Inc., Dept. 397, P.O. Box 9500, Bridgeport, Conn. 06602.

Remington research and development have modified the base wad of the standard 2¾" hull to provide more internal volume. Heavier loads need a proportionate increase in powder for velocity and range. Remington 2¾" magnums contain

Remington 

Great guns deserve great ammunition. We make both.

"Remington" and "Power Piston" are trademarks registered in the United States Patent Office.

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PS Readers Talk Back

[Continued]

tem. His unawareness of the existence of an operating model is understandable since there has been little publicity. We've had a working vehicle using a 200-pound kinetic-energy-storage flywheel for over three years. The present model, a 1971 Camaro utilizing a 57-hp engine in conjunction with a flywheel, has a 35-mpg fuel-consumption rate at 50 mph and 25 mpg in stop-and-go driving conditions. The car has been entered in two clean-air-vehicle road rallies sponsored by the University of North Carolina. A company proposal for additional developmental work is now under review by both the Post Office Department and the National Academy of Sciences.

H. K. MARSHALL,
Marshall Oil Co., Inc.
Wake Forest, N.C.

Pressure-plate gaffe

In "Say Smokey" [Sept.] there is an error. The last sentence of the answer to P. V. Roberts reads, "Your only real fix is a new clutch plate." It should read, "Your only real fix is a new pressure plate."

TED FLAXTON, Atlanta, Ga.

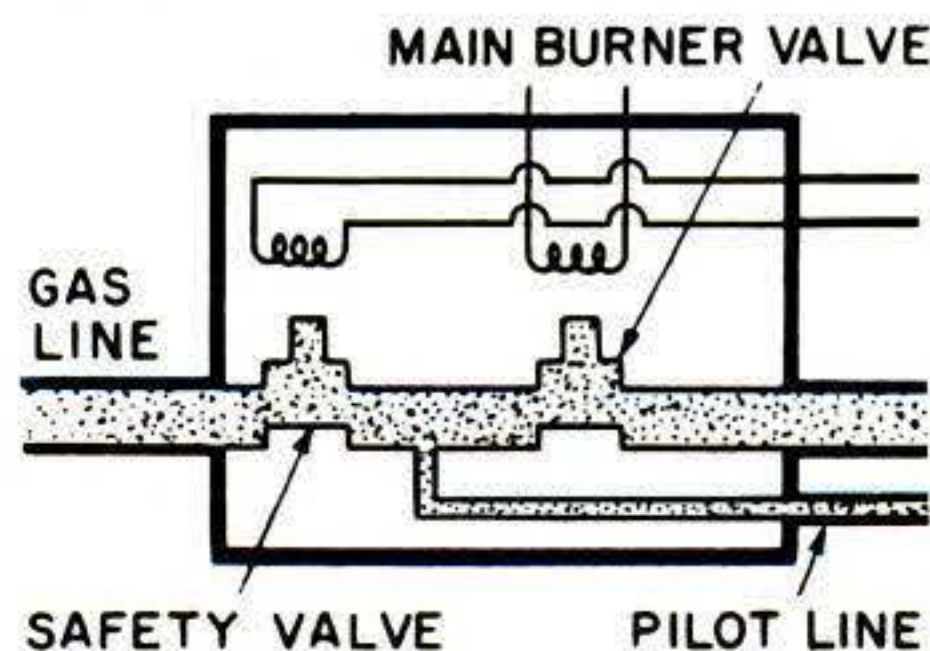
Right you are.

Gas-burner error

In your special home heating section "More Heat, Less Fuel" [Oct.], you explain how a gas burner works. I'd like to know how the pilot light gets its gas when it's connected in line after the main burner valve.

FRITZ AHLER, Twin Lakes, Wis.

It can't; an error crept into the sketch and the two valves were reversed. Here's the correct sequence:



Heating your home efficiently

Robert Gannon's article "Will Heat Pumps Make a Comeback?" [Oct.] does an excellent job of pointing out the problems and promises of heat pumps. However I must point out an error in the reference to my testimony before the New York Public Service Commission. The resistance-heated home consumed 2.06 (not 2.6) times as much fuel as the gas home. The comparison was made for the New York City area, specifically, and makes the heat pump and resistance heating look somewhat worse than the national average be-

cause Con Edison's efficiency is lower than the average (25.2 vs. 29.5 percent). At the national average, the resistance-heated home would consume about 75 percent more and the heat pump 13 percent less fuel than the gas-heated home.

JOHN MOYERS,
Oak Ridge Nat'l. Lab.—National
Science Foundation Environmental
Program, Oak Ridge, Tenn.

Successful barn

Enclosed find a photo of the red barn I built using plan number 5510.



I increased the dimensions from 8-by-12 feet to 10-by-16. Also, instead of using 1-by-6 siding, I used 1-by-12. Finally, in place of the sliding door I used a double-hinged door. I might add that I've never built anything larger than a doghouse. That's proof enough that anyone who can read these simple plans can certainly build the barn.

A. N. STRICLAND, Florence, Ala.

Electric cars: breakthrough what?

I wonder if you'd straighten me out on the subject of electric cars. First, you tell us in "New Electrics Make Performance Breakthroughs" [Feb., '71] that they only need a 20-minute recharge, go 90 mph top speed, and make it 300 miles nonstop. Then you contradicted yourself in "Electric Vehicles Keep On Coming" [Apr.]. This article stated a top performance of 60 mph, 60 miles nonstop, "but we still need a breakthrough on batteries."

STEPHEN UZZO,
Dix Hills, N.Y.

The second article was a straight news report of an electric-vehicle trade show held in San Francisco. The cars shown there reflected the general state of existing technology in the field. As stated in the article, Robert Aronson, builder of the EFP electrics that we reported on earlier, did not exhibit his cars at the show.

PS

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 380 Madison Ave., New York, N.Y. 10017

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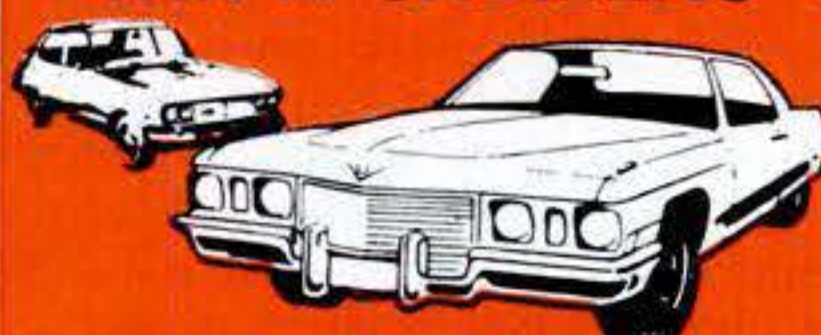
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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" *Popular Science*, 380 Madison Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

Replacing an engine

It seems that everyone knows how to put a bigger engine in a car, but no one knows what should be done to the car when replacing a larger engine with a smaller one.

I have a 1966 Corvette that was originally equipped with a 427-cubic-inch engine. My problem began when I replaced the 427 with a 327, 350-hp engine.

The front of my Corvette now sits about two inches higher than the rear. To correct this condition, different dealers and speed shops have suggested the following: Change the front springs, add a leaf to the rear transverse spring, jack the rear end, and finally, install air shock absorbers using a higher air pressure in the rear shocks.

No one seems to know whether the rear antisway bar that came stock with the 427 is beneficial or detrimental when used with a 327. I have also been advised to have the rear-wheel alignment changed. About the only consistent answer I have received is that the larger front anti-sway bar is beneficial.

What do you suggest I do to the suspension to gain optimum handling for everyday use? The car is equipped with steel-belted radials.

JESSE H. DIZE, Fort Bliss, Tex.

Go to your friendly Chevy dealer. Check with his parts department and get a set of springs sold for the small engine version. The rear sway bar might be a little too big with the lighter engine, and you may have rear oversteer. In any case, with the correct springs recheck wheel alignment. The change in weight won't affect alignment, but the ride height will. Sway bars will have to be balanced—that is, if the car understeers, lighten the front bar and/or increase rear bar, or reverse this if it oversteers. This applies to any kind of tire.

Weird oil-loss problem

My 1972 Pinto has been losing about one quart of engine oil every 1000 miles since the day I bought it. Three trips to the dealer have not remedied the problem. Valve seals were replaced twice, and a

valve-cover gasket was changed on the third visit. The oil loss becomes more pronounced at high speeds.

On a 200-mile trip that was all expressway driving, the engine lost half a quart of oil. Average speed was 50 to 55 mph. The engine looks wet around the oil-filler inlet pipe, and there seem to be puddles of oil in the filler pipe. Speaking to six other Pinto owners, I discovered that they are experiencing the same problem. Ford Motor Company has been unable to correct the situation or explain the cause. Can you?

NORMAN EIDER,
North Brunswick, N.J.

I have to answer you in a general way since I don't know personally of any Pinto oil-consumption epidemic. The four biggest causes of oil consumption are: leaks (but this doesn't seem to be your problem); bad cylinder-bore finish or bad rings (an engine blowdown test usually will pin this down); poor crankcase ventilation (look carefully here—if your crankcase pressure is above normal, it must be corrected, and this would be the area I'd be most suspicious about); oil leaking down the valve stems (you indicated this has been worked on, but if a positive fix hasn't been achieved, it could still be the trouble).

High crankcase pressure will make otherwise normal engine components unable to control the oil properly.

Blown spark plug

The day after we returned from a 400-mile trip, my wife backed our 1971 Ford Country Squire out of the garage, heard a flutter from the 351-CID engine, drove about a mile, then heard a loud bang. Inspection at the nearest gas station showed that the left-front spark plug had blown completely out of the block.

I put that plug in myself—tight, but not too tight—3000 miles before. How could this happen? Could it be that the plug cracked from heat and spewed out a little bit at a time until what was left blew out all at once?

BERNARD H. GOULD,
Lake Clarke Shores, Fla.

I don't have a concrete answer to give you. But I've heard of this happening before. Apparently the in-

ulator becomes loose after losing its sealing power. Now, what causes this—whether the plug is tightened too tight, or improperly made—I don't know. But if you still have the bad plug and will send it with a letter explaining the problem to Ford Motor Co., Spark Plug Dept., Room E010, Bldg. EEE, 21500 Oakwood Blvd., Dearborn, Mich., I believe they will answer you. It's my guess they would like to see that plug.

Battery storage

I recently acquired a good battery that I may not need for a year or two. How do I store it? The best idea I've heard so far is to charge it, drain and save the acid, and fill the battery with plain (or distilled) water to keep the plates from drying out and crumbling.

ED HUSER, New York, N. Y.

If it has never been charged, I think the best way to store a battery is dry. Once you charge a battery with liquid I believe the plates must be covered with liquid and kept in at least a minimum charge condition. Anything else is a compromise. I realize I may have opened a Pandora's box. But I never did say I knew everything.

Install electronic ignition?

I'm thinking of installing an electronic capacitive discharge ignition system on my '69 Mustang to prolong the time between tune-ups. I do not always believe everything the advertisements claim, so I'm asking advice from an expert.

Do you think solid-state ignition improves engine performance? If so, how can I determine which system is the best buy?

JOHN REINS, Imperial Beach, Calif.

CD ignition will do what you think. Most brands of solid-state ignition work well. Stick to brand names and compare prices, including installation charges, to see which is cheapest. But I question whether you'll recover your investment unless you keep your car three or four years longer. When you trade the car in, it would, in my opinion, be wise to make sure the next car has solid-state ignition.

Starting problem

I have a 1967 Ford six-cylinder that I bought new. Last summer the ignition switch became erratic, sometimes turning the starting motor on and sometimes not. When the starting motor couldn't be turned on with the ignition switch, it could be turned on at the solenoid by shorting out the switch. I have replaced both ends of the ignition switch to no avail. When I turn the key on and off a few times it sometimes works, but usually I have to short out the ignition switch by leaving the switch on and shorting it out at the sole-

Continued

AC INTERVIEW:

Roger Mears • Ralph Bruning

A candid conversation with the men who challenged the mountain and won.

Nothing causes the blood of drivers Roger Mears and Ralph Bruning to run faster than the thought of racing up the side of a mountain in off-road competition—and coming in first. Both did just that at the 51st Pikes Peak Hill Climb. Roger, for the second year in a row, won in the open wheeler class with a winning time of 12:59. And Ralph came within two seconds of Bobby Unser's stock car record by winning in 13:42 in a 1970 Chevelle. Their comments follow.

AC: Ralph, the Pikes Peak is one of the most grueling off-road races going. What makes it so tough?

Bruning: Well, there are three things. Altitude—you're starting at 8,000 feet and climbing to over 14,000 feet. Then there's the incline of the road—it gets steeper the higher you go.

And on top of this, you're running your engine at constantly higher RPM's.

AC: Roger, what type of stress does an event like this put on an engine?

Mears: I'll tell you. The Pikes Peak's 12 minutes, with that constantly increasing incline, can be a lot harder on your engine than some events that last hours. Your engine and spark plugs never have a rest.

Bruning: I'd like to interject. I used the very same set of AC Spark Plugs all year long, in all my racing, and never changed spark plugs once.

AC: You mean you ran that same set of ACs in 1972 that you ran the hill with and won in 1973?

Bruning: Right. Every day of practice and time trials. And the event itself.

AC: What did they look like when you pulled them out?

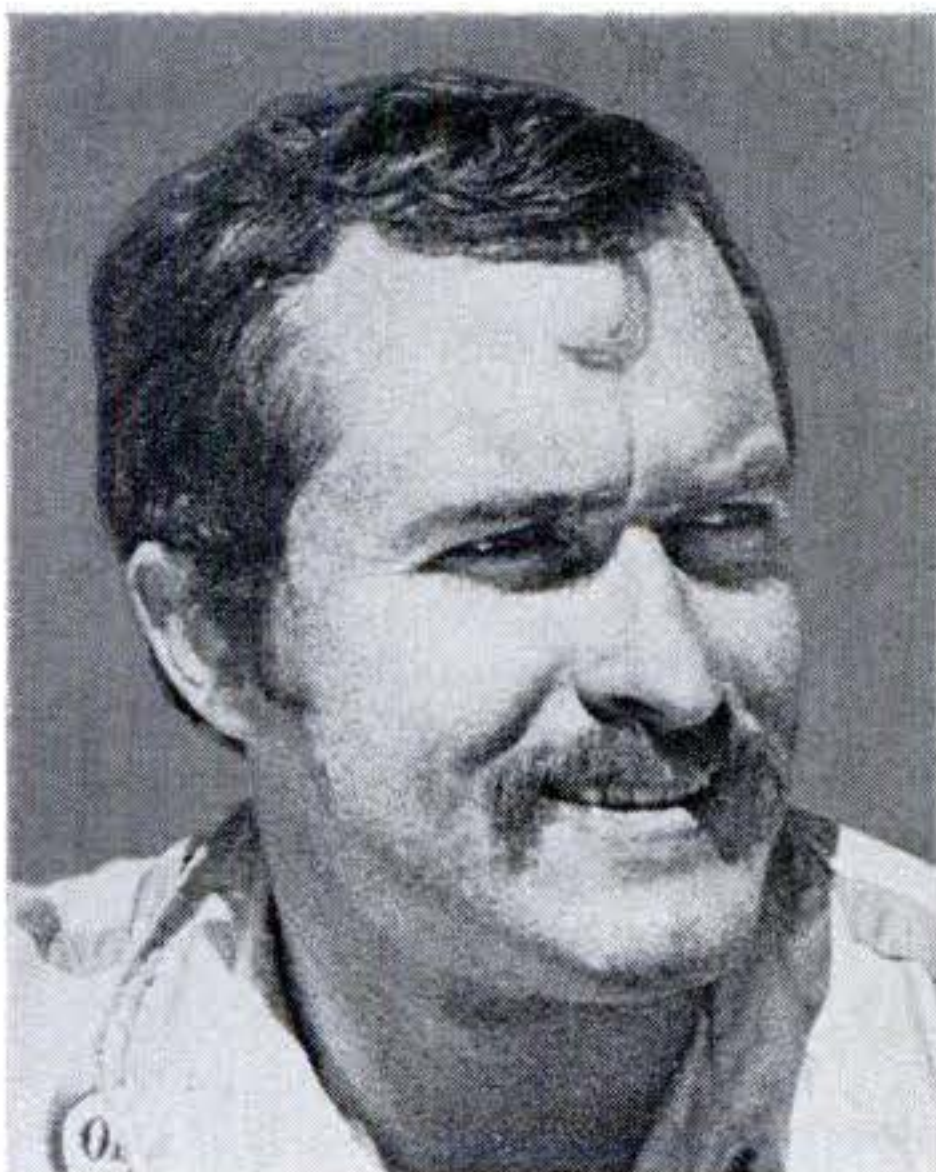
Bruning: They looked good.

AC: Roger, how about you . . . on what do you gauge a spark plug's performance?

Mears: Getting the job done. Nothing else. I've experimented with both foreign and domestic spark plugs, and found that ACs really do the job.

AC: Ralph, could you be more specific?

Bruning: Well, on Pikes Peak, we need a spark plug that will not foul out under severe acceleration and relatively low RPM. You're going through sharp turns, where you'll be pouring a lot of gasoline in there, and you've got to be able to come out of a turn when you floor it. I mean, these plugs have to suffer a lot of abuse. I tell you . . . it must say something because we ran hard with those ACs—against a tough field—and won!



Ralph Bruning of Lawton, Oklahoma. Winner of the stock car event in a 1970 Chevelle with a winning time of 13:42. Just two seconds off Bobby Unser's all-time stock car class record.



Roger Mears of Bakersfield, California. Winner of his second consecutive Pikes Peak Hill Climb. Mears ran in the open wheeler class. His winning time? A quick 12:59.



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"Say, Smokey—"

[Continued]

noid. Got any idea what's causing the problem?

JAMES F. CREIGHTON,
Toledo, Ohio

I think you'll find the problem in the starter solenoid. What you call shorting out is in fact putting current across the solenoid and jumping part of the circuit. There are several other things that could cause the trouble inside the starter, and I'd recommend you have it pulled and looked at completely. If you run the starter full of dirt and with worn-out brushes, it will cost more to fix in the long run.

Clunking in the rear

Rear-end trouble—that's my problem. I have a 1972 Javelin, 304 engine with a two-barrel carb. When I accelerate to 30 mph and let up on the gas pedal I hear a loud clunk in the rear. If I step on the gas pedal, it clunks again.

I've had the car back to the dealer three times. A factory man looked at it and told me that the car was made that way. I only have 8000 miles on it. Any idea how I can fix it myself? The problem isn't caused by the driveshaft. It's tight.

R. D. GRIFFITHS, Baltimore, Md.

Sounds like torque lock where the driveshaft is supposed to adjust for length when the rear axle travels up and down. If that's what it is, there's no real answer that works every time. Usually, no damage is done. As the car gets more use, the problem sometimes goes away. But if the play and clunking is in the differential, it will shortly cause you some real trouble.

Apparently you don't trust the factory rep, so I have two suggestions: Find a way to try three or four cars like yours and compare them. Or find another dealer and check with his service department for an opinion. If they agree it's okay, that gives you pretty good odds that nothing is seriously wrong.

But one thing keeps running through my mind: Usually nobody makes cars with a built-in clunk.

Fan-jet in car?

Some time ago I installed a fiberglass fan blade on my 1964 Chevy Impala SS, and now at speeds above 40 mph there is a loud roar like a jet. Can this fan blade cause the noise? The exhaust pipes and mufflers are all new and tight.

GUS A. GREEN, Boron, Calif.

There's a quick way to find the answer, Gus. And it won't cost you anything, either.

Take the fan off—it's not all that hard. Now run the car up to 50 mph. It won't hurt it, and you'll have your answer. Could save a lot of guessing.

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Dirt Squirt handles very well in the corners, Hill finds out as he zips around a motocross track. He rates this machine as a top-notch bike for beginners. Its light weight (185

pounds dry) contributes to its quick, responsive handling. Just about any advanced riding technique you can think of, even a wheelie (inset photo), can be practiced on this bike.

HODAKA DIRT SQUIRT: Great Dirt Bike for Beginners

It's ready for the rough stuff, but docile enough for the novice to ride easily

By **RAY HILL**

PHOTOS BY RAY AND MAIREAD HILL



Spunky little 100cc power plant is readily accessible for repairs or adding optional equipment. Racing cylinder is available to increase engine performance.

DIRT SQUIRT SPECS

Engine	2-stroke, air-cooled
Lubricating system	gas/oil mix
Displacement	98cc
Bore and stroke	50mm x 50mm
Compression ratio	8.6:1
Carburetor	Mikuni VM20-SH
Ignition	flywheel magneto with ignition coil
Transmission	5-speed, constant-mesh
Gear ratios	1st: 38.94:1 2nd: 26.49:1 3rd: 18.90:1 4th: 13.81:1 5th: 11.32:1
Wheelbase	51.18 in.
Ground clearance	8.86 in.
Weight	185 lbs. dry
Cost	\$555

Let's say you've got the urge to go trail riding. Got it so bad that you're ready to buy a bike. Trouble is, you've only ridden a motorcycle once, and it was a street bike. What do you do?

Shop around. Compare prices and features. And when you do, take a look at the machine I just finished testing—Hodaka's new Dirt Squirt.

Dirt Squirt has it all. It brings you everything a first off-road bike should have: a comfortable low seat that lets you easily put both feet on the ground for balance in rough spots; and a 100cc two-stroke engine with a five-speed transmission that transmits enough power to the rear wheel to let you tackle those steep hills with confidence, but not so much that you get into serious trouble if you forget and crack the throttle open when you shouldn't.

Upswept muffler, high ground clearance, and distinctive chrome gas tank

I tested the Dirt Squirt on both woodland trails and a motocross track. Over rocks, logs, sand, and mud I found handling to be first rate. The shocks never "bottomed out" and the brakes brought me to a quick fade-free stop whenever called for.

Another good feature of the Dirt Squirt: As your riding skills increase and you begin to feel the need for a little more performance under the gas tank, you don't have to buy another motorcycle. Standard parts from other Hodaka bikes can be bolted on. Lights, a 100cc racing cylinder, a longer swing-arm to increase wheelbase, and bigger tires are among items you can buy.

If you're ready for a first off-road motorcycle, you'll be cheating yourself if you don't take a hard look at the Dirt Squirt. **P5**

of Dirt Squirt (foreground) matches that of bigger Hodakas in background.



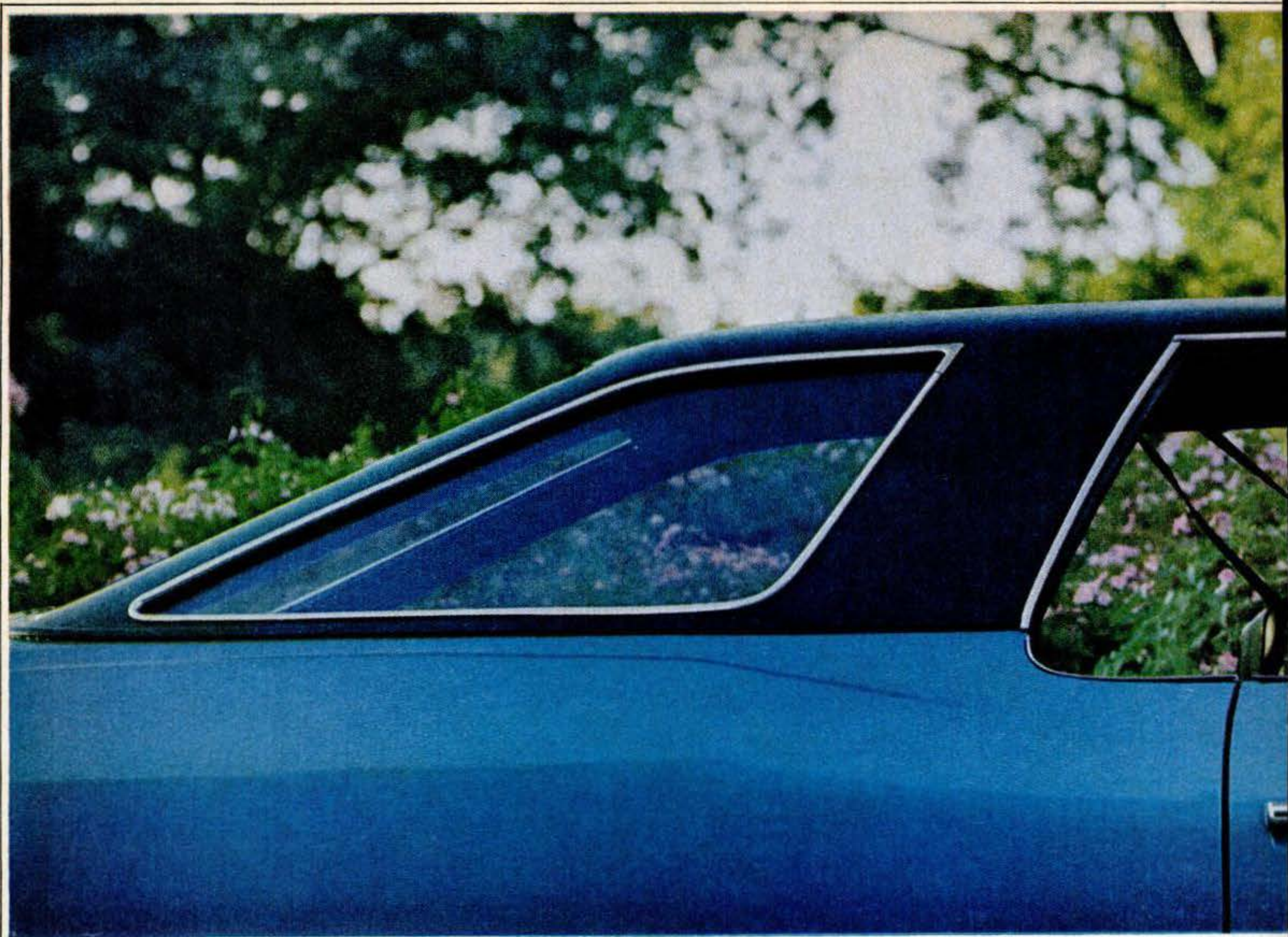
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The colonnade roof featured here is shown with an available vinyl top.



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The improvement is our new colonnade roof, which you'll find on many full-size General Motors cars for 1974. We wanted to create a look that was both contemporary yet timeless—and built for strength. And thanks to thin but strong roof pillars, our new colonnade roof gives you more glass area all around and a feeling of spaciousness for every passenger. What's more, the roof itself has a double construction—two panels of steel with the inner panel acoustically perforated to help absorb sound. All this you'll find in our new colonnade roof. The hard-to-top top from GM.



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Look and Listen

News, comment, and opinion from the world of home-entertainment electronics

By JOHN R. FREE

ICs for quadraphonics

Integrated circuits for decoding quadraphonic recordings are starting to pour off assembly lines. They've been expected for some time [L&L, July '73], and their enormous potential for four-channel equipment is already becoming apparent. You're going to see quadraphonic hardware that's less expensive, more compact, and more sophisticated.

At the moment, there are three leading contenders in the Great Quadraphonic Battle: CBS's SQ-matrix system, Sansui's QS matrix technique, and JVC's discrete CD-4 system. Matrix recordings blend rear-speaker information into the regular stereo channels; CD-4 encoding keeps the rear channels separated (discrete) from the stereo in front.

Here are the latest developments in quad ICs:

- Motorola and Sony are introducing three-chip IC sets for decoding SQ records (and broadcasts). One of the Motorola chips can be used for basic SQ decoding and undoubtedly will turn up in most mass-market equipment. All three chips are needed for so-called "full-logic" decoding. With basic SQ decoding, there's minimal sound separation between speakers. Full-logic circuits regulate the volume of each speaker, making the sound more directional and realistic. (Some equipment has an intermediate circuit that boosts separation between front and rear speakers.)

Until now, full-logic circuitry was too complex and expensive for most hi-fi equipment. One receiver containing the full-logic circuit is Lafayette's LR-4000. Quad enthusiasts can buy "black-box" decoders that plug into four-channel amplifiers. Sony, which adopted CBS's SQ early, makes one of these decoders. Their \$200-plus SQD-2020 requires 69 transistors and 84 diodes. I've learned that next month they'll market a "less-expensive" full-logic decoder with three ICs, nine transistors, and 19 diodes. Motorola's three-chip, full-logic ICs should soon appear in black-box decoders, too. Sherwood's S-7244 reportedly will be one of the first receivers to use them.

- Sansui announced that Hitachi is making a three-chip decoder for

their Vario-Matrix QS system. Like CBS's full-logic, Vario-Matrix is a more sophisticated version of basic QS circuits in use for some time. Vario-Matrix enhances quad sound by altering phase relationships of audio signals. The sophisticated circuit is available in black-box decoders and some Sansui receivers. Hitachi's ICs will trim production costs, making receivers and add-ons less expensive.

- CD-4 chips to decode discrete (nonmatrix) records aren't on the market yet. However, Quadracast Systems, an early developer, may offer ICs this spring. Semiconductor manufacturers could introduce other chips earlier.

While the CBS and Sansui matrix systems have varying levels of decoding sophistication, CD-4 circuits are basically standardized. Some CD-4 circuits do the job better than others, just as some stereo-decoder circuits in FM sets perform better than others.

What about those super all-in-one receivers built to decode any quad material? Most contain basic SQ and QS decoding circuits. As less-expensive IC black-box decoders are introduced, some all-in-one receivers could be upgraded. But this plug-in approach with decoders is just what the all-in-one receivers were supposed to eliminate.

It looks as if the new ICs will provide fresh ammunition to contenders in the Great Quadraphonic Battle. We'll be seeing quad equipment with at least three decoding switch positions for some time.

Quad at AES

I attended a recent skirmish between quad contenders at New York's Waldorf-Astoria. At the Audio Engineering Society's 46th convention, Columbia Records played SQ discs through Motorola's three-chip decoder circuits. Sansui demonstrated their Vario-Matrix, switching back and forth between QS and a four-channel tape. The matrix decoders provided impressive sound—good separation and directionality—but couldn't match the extraordinary quad "presence" of JVC's units. Their latest CD-4 discs created an exceptionally live atmosphere in the room—as though it was filled with musicians. I noticed the presence even standing in the doorway. With

matrix systems, you generally must position yourself between speakers for an adequate quad effect.

New video discs

As Teldec and Philips were introducing new versions of their video-disc players at September's Berlin Trade Fair [see What's New, this issue], word came of two more disc players under development.

Wolfgang Bogen GmbH, a German tape-head manufacturer, demonstrated a disc recorder/player using a modified phonograph turntable. The discs, coated with chromium-dioxide material, spin at 156 rpm (78 rpm in future versions) while a new type of head records and plays back video. The discs, at \$4, should hold 12 minutes of color a side, says the developer.

In France, Thomson CSF showed a player that uses a laser-scanned transparent disc for up to 20 minutes' playing time. Philip's system [PS, Dec. '72] and the similar MCA DiscoVision [L&L, March, Sept. '73] use laser-scanned discs with reflective metallic coatings. Teldec's approach [PS, Jan. '71] uses discs with stylus-decoded microthin grooves. So far, no one has set a firm U. S. distribution date.

TV cameras on a chip

Weaving through laser beams at the Electro-Optics '73 exhibition in New York, I spotted GE's entry into the tubeless TV-camera field. Their 10,000-element chip was mounted in a case slightly larger than a deck of cards. Fairchild recently introduced a similar pocket-size camera [L&L, Nov. '73]. RCA also unveiled a 120,000-element chip and camera, suitable for standard 525-line TV. They expect to have models that can match vidicon tubes in performance shortly.

Music to listen to equipment by— By Arthur Fisher

Stuck for a Christmas gift? Here are some recent disc releases to delight any owner of a stereo rig. Some have been reviewed here before; most not. All share a state-of-the-art quality of recorded sound that should show off audio equipment to sensational effect (although the recording techniques used may not necessarily result in musical realism or good balance). This selection is, of course, an arbitrary one, and represents only a fraction of the recent releases that might have been included.

The recordings range from solo instrumentals to very complex combinations of large chorus and orchestra. The latter make severe demands on sound equipment, with distortion a particular problem. Orchestral records let you listen for the clean sound of massed strings that means

Continued

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For the little jobs, the XL2 has a trigger up front.

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In designing your first chain saw, we at Homelite had to decide whether to give you an extremely low price and very little chain saw. Or a lot of chain saw and sell it at a price we could both live with.

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the same Power-Tip® sprocket nose professional loggers use to boost their cutting power.

Your first chain saw has an all-weather ignition so that it starts when you want it to start.

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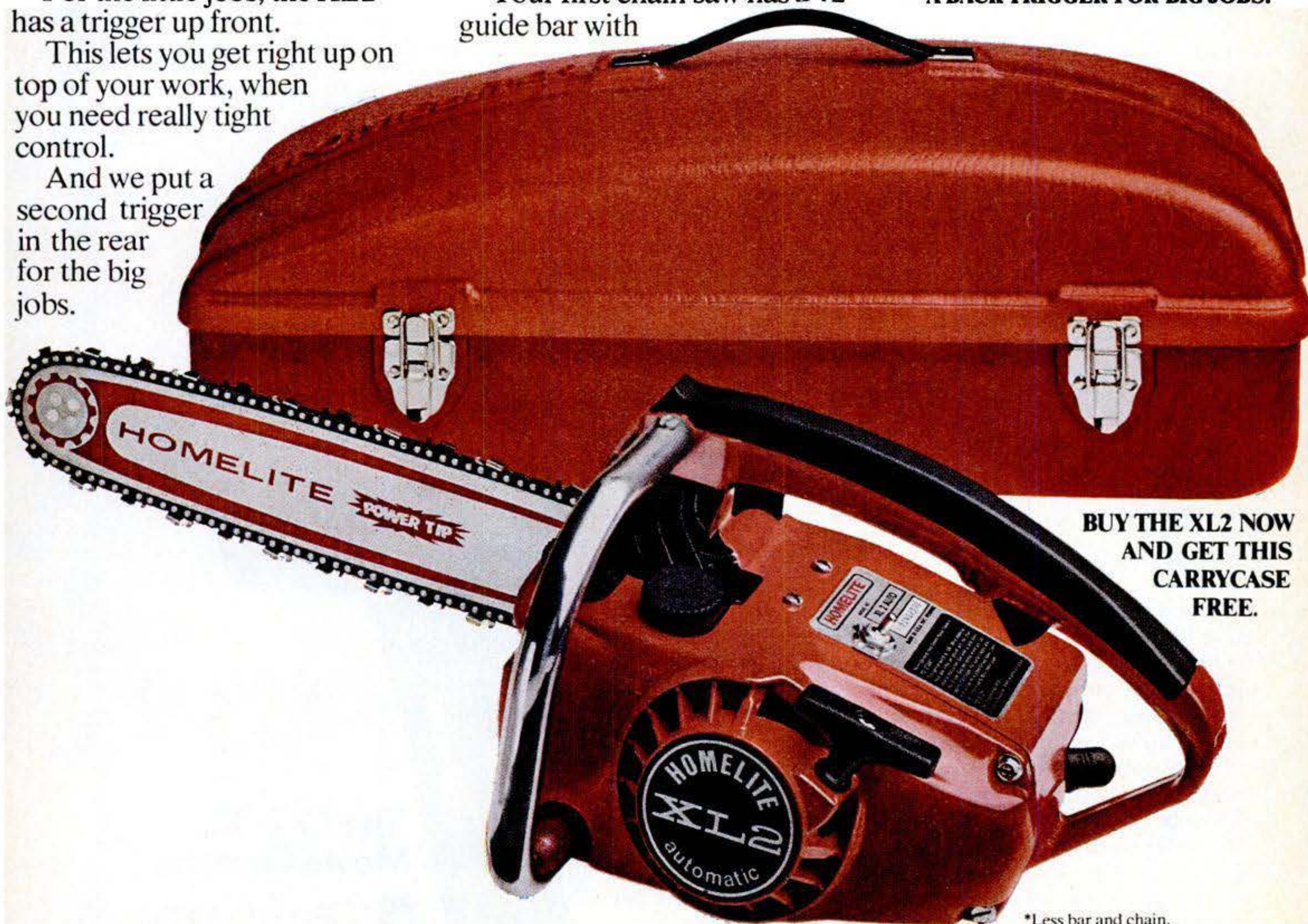
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Look and Listen

[Continued]

extended highs, realistic brassy (as in the Bruckner and Hindemith), the crisp percussion that means good transient response and wide dynamic range. Listen to pop, rock, and jazz studio recordings to judge stereo image—the *Gemini* disc is a good example. Plucked instruments—guitar, harpsichord—are an excellent test of transients and the high end. The piano is probably the most difficult instrument of all to record naturally. And there's nothing like a good organ recording to test for that last, low octave of clean bass.

Divertimento in D major, Serenade in D major—Mozart; Academy of St. Martin-in-the Fields directed by Neville Marriner. Argo.

Gemini; Errol Garner, piano and harpsichord, with various soloists. London.

Piano Concertos No. 1 and 2, Totentanz—Liszt; Alfred Brendel, piano, and London Philharmonic Orchestra conducted by Bernard Haitink, Philips.

Overtures—Handel; English Chamber Orchestra conducted by Raymond Leppard. Philips.

Monster Concert (various works arranged for 10 pianos and 16 pianists); Eugene Liszt and others. Columbia.

Dueling Banjos; Earl Scruggs and others. Columbia.

Music for Harpsichord—Rameau; Albert Fuller. Nonesuch.

Symphonies No. 1 and 9—Shostakovich; Orchestre de la Suisse Romande conducted by Walter Weller. London.

Farewell Andromeda; John Denver. RCA.

Loggins and Messina. Columbia.

There Goes Rhymin' Simon; Paul Simon. Columbia.

Piano Concerto No. 2—Rachmaninoff; Artur Schnabel, piano, and Philadelphia Orchestra conducted by Eugene Ormandy. RCA.

Das Lied von der Erde—Mahler; various soloists with Chicago Symphony Orchestra conducted by Georg Solti. London.

Little Marches by Great Masters (Beethoven, etc.); Netherlands Wind Ensemble. Philips.

Songs from the Volga; the Sea Gull Cossacks. London.

Symphony No. 4—Bruckner; Chicago Symphony Orchestra conducted by Daniel Barenboim. Deutsche Grammophon.

Scheherazade—Rimsky-Korsakov; London Philharmonic Orchestra conducted by Bernard Haitink. Philips.

Mathis der Maler, Concert Music for Strings and Brass—Hindemith; Boston Symphony Orchestra conducted by William Steinberg. Deutsche Grammophon.

Romeo and Juliet—Prokofiev; London Symphony Orchestra conducted by Andre Previn. Angel.

Twenty-four Preludes—Chopin; Christoph Eschenbach, piano. Deutsche Grammophon.

Arp Schnitger Organs in North Germany (Bach, Buxtehude, etc.); Karl Richter and Albert de Klerk. Telefunken.

Symphony No. 9—Beethoven; various soloists with Chicago Symphony Orchestra and Chorus conducted by Georg Solti. London.

English Music for Strings (Holst, Vaughan Williams, etc.); Academy of St. Martin-in-the-Fields conducted by Neville Marriner. Angel.

My Merry-Go-Round; Johnny Nash. Epic.

Chicago VI; Chicago. Columbia.

The Guitars That Destroyed the World; (various rock groups). Columbia.

Paul Horn Inside II; Paul Horn. Epic.

Janis Joplin's Greatest Hits; Janis Joplin. Columbia.

Battle of the Huns, Mazeppa, Orpheus—Liszt; Los Angeles Philharmonic Orchestra conducted by Zubin Mehta. London.

Symphony No. 1—Mahler; Amsterdam Concertgebouw Orchestra conducted by Bernard Haitink. Philips.

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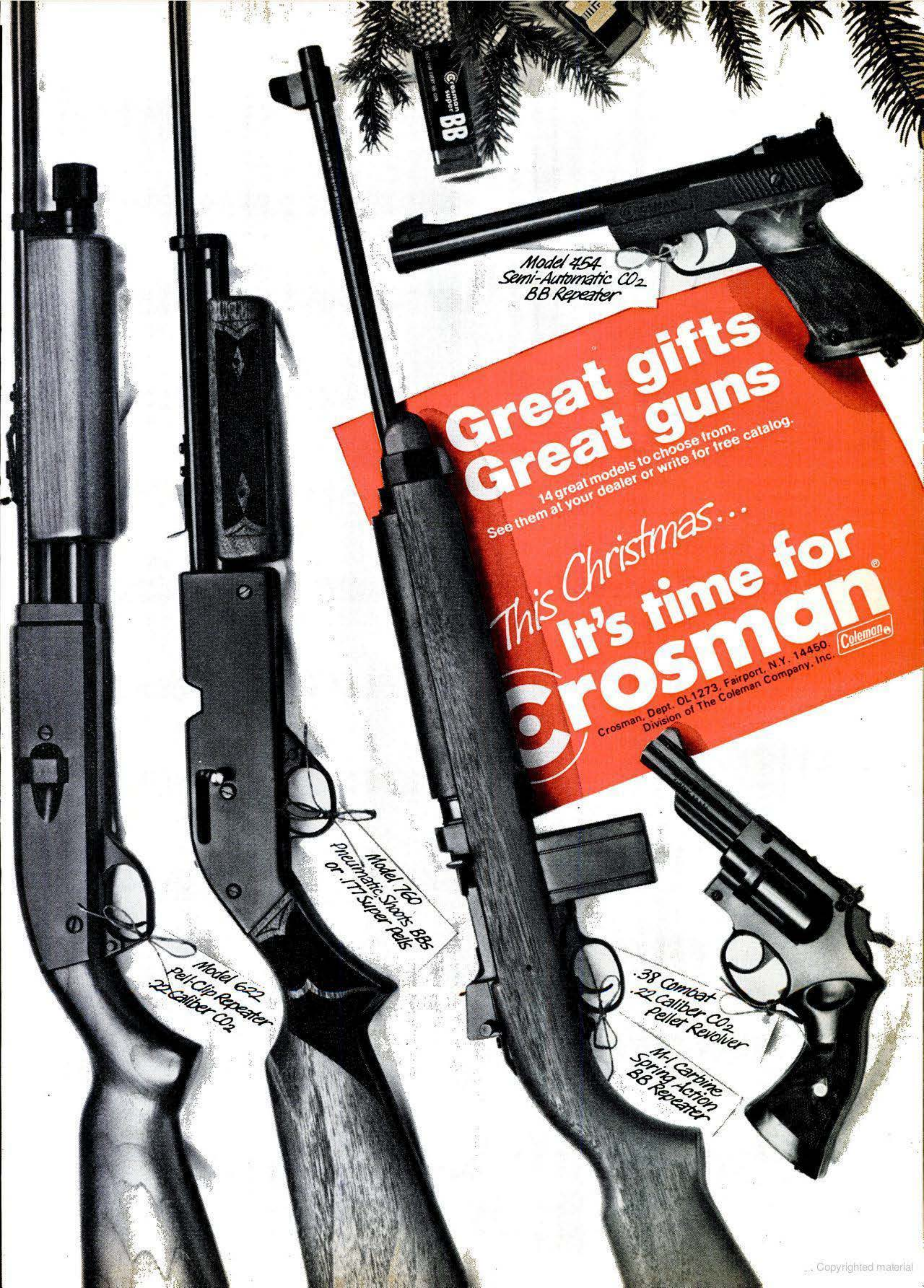
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Penney's electric gives 1-1½ hours of mowing on a charge; with 38-inch deck, enough for most lawns. Batteries are

guaranteed for two years, but should last five, says Lindsley (above). Charger switch (in inset) times automatically.

PERSONAL-USE REPORT

A Rugged Electric Rider

Maybe you've been reading about battery-powered tractors and mowers and wondering if they're really any good. My feeling, after testing most of them, is that the only thing wrong with electrics is that not enough people know about them.

Now, J. C. Penney has moved the electric mower smack into the mass-merchandising world. Their Model 1806 looks like and operates just like the counterpart engine-powered mower. But, like all electrics, it's a lot easier on neighbors' ears, and beats the oil, gasoline, spark-plug, and starting hassles.

Penney's mower takes five hours for an 80-percent charge from a household outlet, tops off in 12 hours. A built-in timer cuts the charger in briefly once each day.

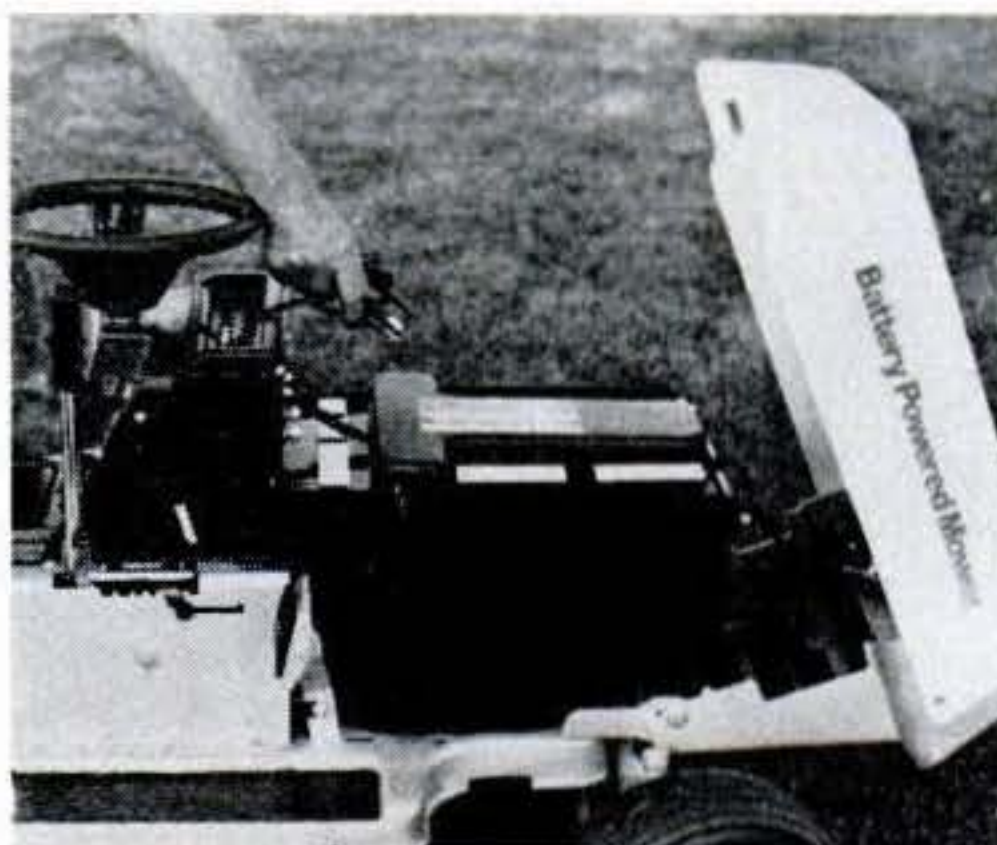
The 38-inch deck has two cutters, each powered by a separate motor. Travel speed is preselected, from very slow to rather lively, by means of a detented lever that varies the flange spacing on the drive-belt pulley. A second lever provides forward, neutral, and reverse. The foot clutch and clutch-lockout lever are interconnected, and depressing the clutch pops the lever back—sometimes into your shin (until you get used to it).

The cutter deck can be set at either "full-float" to let the deck follow the ground contour, or "suspended" to hold it above rough spots. Important feature: The deck-

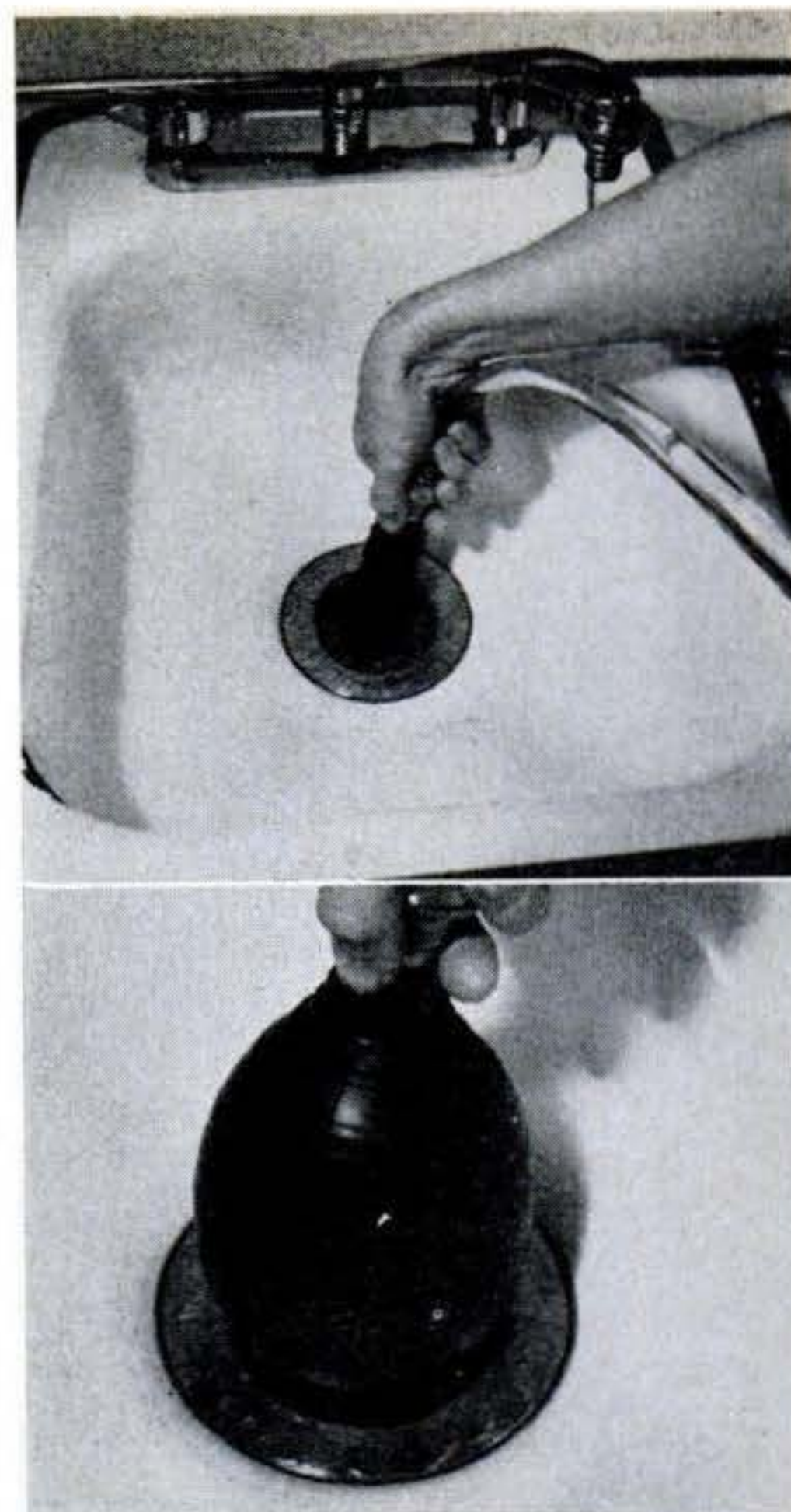
lift lever lets you hoist the deck momentarily to pass over a high spot and then drop it back to a preset height.

I thought a few things about the Model 1806 could be better. The turning radius is not quite snug enough to come around as tightly as I'm used to, and there is simply not sufficient clearance for raising the deck up tight against the tractor underside—it's possible to get yourself belly-hung on steep rises.

One thing that impressed me was the overall appearance of good construction, snug rack-and-pinion steering, replaceable bronze bushings at wear points, and a basically simple, rugged drive system. Price: \$799.—*E. F. Lindsley*



Cord from built-in, solid-state charger plugs into household outlet. Filler caps are handily placed for adding water.



Connect unit to faucet with hose, insert in drain, and turn on water. Drain King expands for tight fit, then sends jets of water through surge valve until blockage is flushed. (To show action, photos were taken in sink.)

Puff-and-Pulse Drain Clearer

If plungers and plumber's bills get you down, this gadget might be just what you're looking for. Drain King connects to your garden hose and uses cold water from any faucet in your house to unclog sinks, toilets, and drains. It also primes and flushes pool pumping systems.

It's available in several models to fit pipes from one to six inches in diameter, at prices from \$4 to \$11. G. T. Water Products, Inc., 15155 Stagg St., Van Nuys, Calif. 91412, makes it.—*R. L. Stepler*



Complete kit includes 10-foot hose and faucet adapter, which lets you connect Drain King to any threaded faucet.

Have one of mine.

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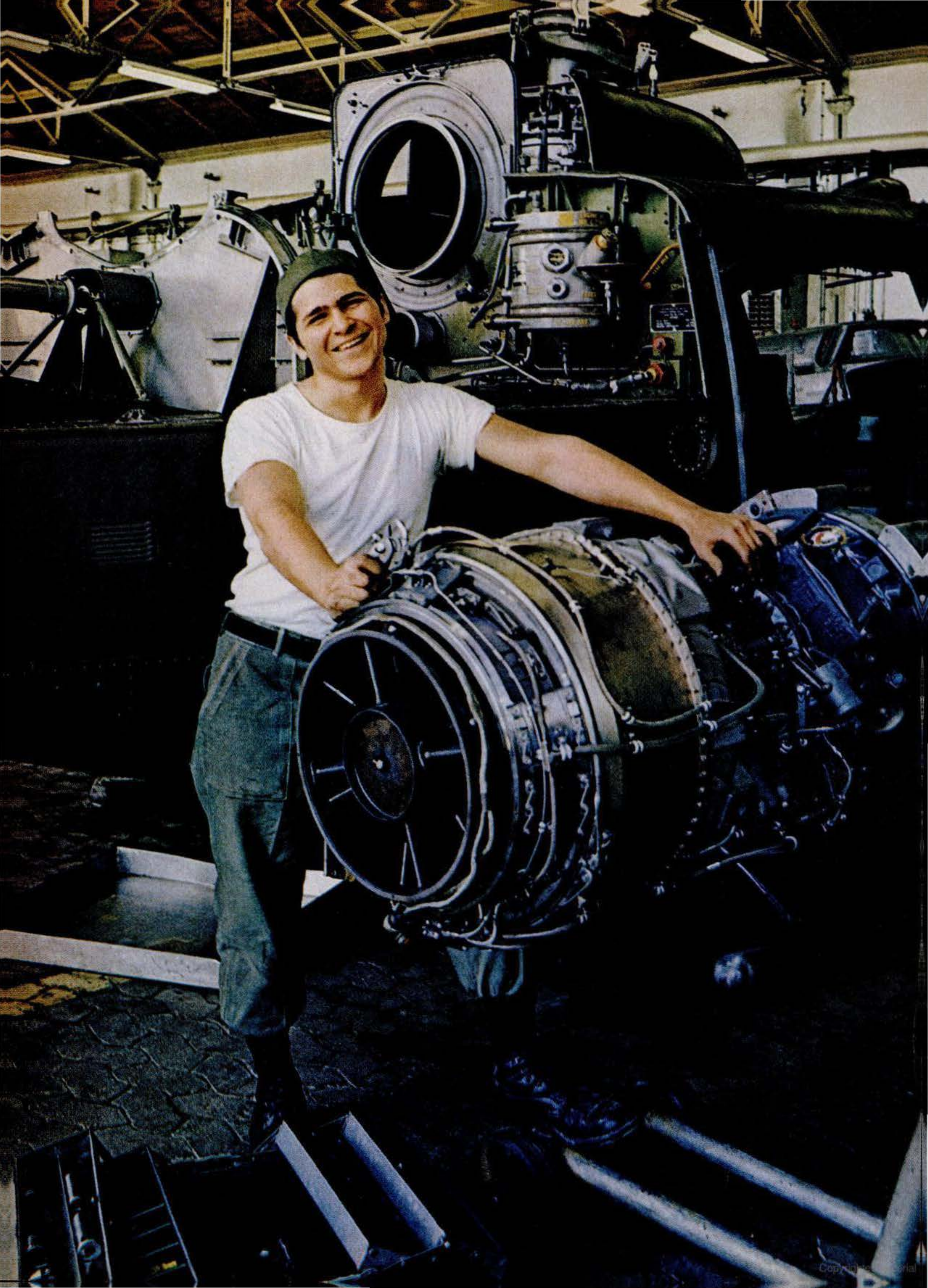
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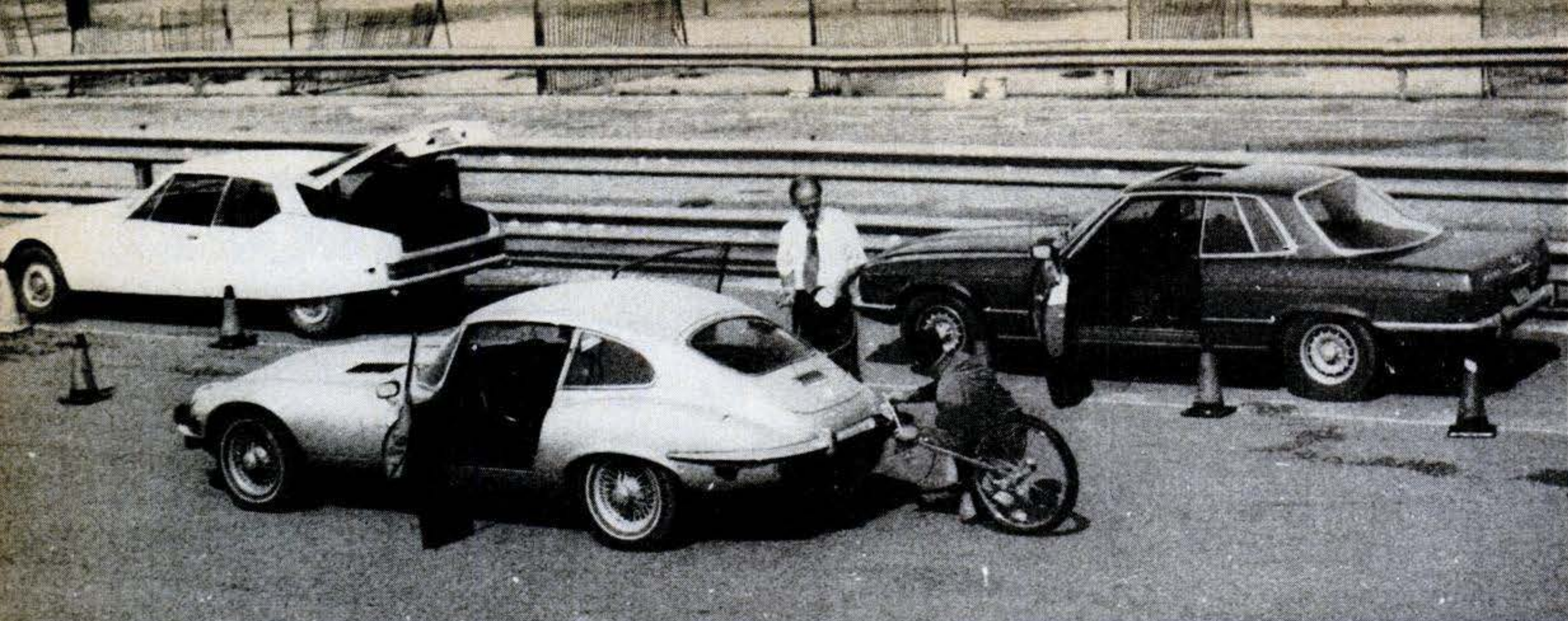
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Ready for testing, cars have full tanks and recommended tire pressures. Norbye hooks the fifth wheel to the Jaguar as

Dunne wires up the electric speedometer. Citroën (left) and Mercedes wait their turns.

PS Ratings—Test Report in a Nutshell

The table below shows our ratings for 10 performance or design areas in the three vehicles tested. The ratings are based strictly on test results and actual measurements. Personal bias or subjective opinion play no part, as the ratings have a direct mathematical relationship to test data and specifications. Five points is excellent; 4, very good; 3, good; 2, fair; 1, poor; and 0, very poor.

	Citroën SM	Jaguar V12 E-Type	Mercedes 450 SLC
Acceleration	5	5	5
Brakes	5	4	5
Handling	5	5	5
Maneuverability	5	5	5
Fuel economy	2	0	2
Quietness	2	0	2
Ride comfort	4	2	3
Roominess	3	2	3
Visibility	5	3	3
Entry/exit ease	2	1	2



They're built for high-speed travel with maximum safety and comfort: Citroën SM, Jaguar V12 E-Type, Mercedes-Benz 450 SLC

EUROPEAN THOROUGHBREDS: What Are Their Secrets?

By JAN P. NORBYE / *PS Automotive Editor*
and JIM DUNNE / *PS Detroit Editor*

PHOTOS BY ORLANDO GUERRA

If you drive one of these cars for a while, you'll be amazed at the number of people who come up to ask questions about it every time you stop. Now we'll answer their questions—and perhaps some of yours, too.

For starters, take a look at the rat-

ings. All three cars have excellent scores in several key areas of performance. (For more specific figures, check the test results.) But numbers don't tell the whole story.

Putting these machines through the same test program we use for all

Continued



Citroën has futuristic instrument panel. Steering column has both telescopic and height adjustment. Seats adjust for fore-and-aft travel, thigh support, and back-rest angle. A/C is standard.



Mercedes interior has strong family relationship to sedans from Stuttgart, with accent on safety. Large steering wheel has padding on hub and spokes. Shift lever has padded knob. A/C is standard.



Jaguar instrument panel suggests World War II fighter-plane cockpit, with vast array of gauges and dials. Three-spoke sports steering wheel has telescopic column adjustment. A/C is standard.



The image shows a large, white DieHard battery in the foreground. In the background, five cars are parked in a row, their headlights on, and they appear to be starting or have just started, with smoke or steam rising from their engines. The scene is dark, suggesting a nighttime or low-light environment. The battery has the word "DieHard" printed in large, bold, black letters. A small "Sears" logo with a checkered flag is visible on the right side of the battery.

DieHard



**This two-year-old DieHard[®] really started something.
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Five cars with dead batteries are sitting in a parking lot. Jumper cables from all five are connected to a Sears DieHard battery.

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The DieHard is available only at Sears Tire and Auto Centers. Or through the Sears, Roebuck and Co. catalog.

*Test certified by United States Auto Club.



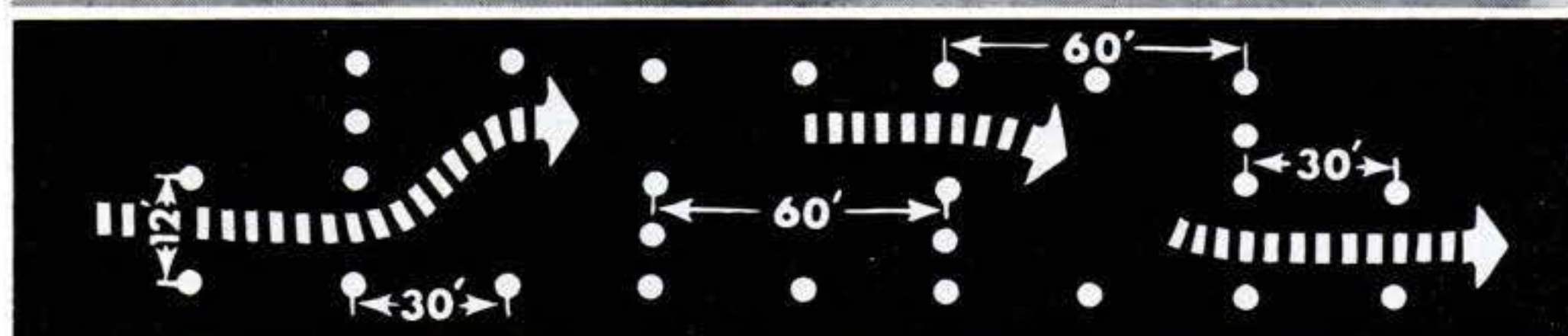
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PS Handling test: high-speed emergency swerve

Two lane changes in quick succession show a car's evasive ability at high speed. The higher the speed at which the car can run through the grid without hitting the pylons, the better its handling precision. Each car makes a number of runs at increasing speed until it is on the verge of going out of control. Runs are stop-watch-timed. Driving skill has been found to play no part in the results, as a car's highest speed in this test is limited by some inherent characteristic (excessive understeer, oversteer, drifting, slow response, vague or slow-geared steering).

Mercedes (above) has mild understeer and is very stable up to the point where rear-suspension roll oversteer sets in (note tail drifting out). It helps around a long curve, but is not desirable on S-bends. **Jaguar** (top right) is almost free of roll despite high side forces on car as it changes lanes. It has stronger understeer than Mercedes but is free of roll-steer effects. Incipient rear-end break-away limited its speed, however. **Citroën** (lower right) has considerable body roll but is free of roll-steer effects. Steering precision is superior in all situations, with full stability and remarkable directional control.



other cars was a dramatic experience, because we knew we were flirting with the limits set by the laws of physics, particularly in the braking and handling tests. The results, incidentally, gave us a valuable check on the validity of our test methods, and our rating system. These cars proved that our standards are realistic.

What makes a thoroughbred? Each car is a marvel of modern engineering. We have published technical descriptions [Citroën SM, PS, Sept. '70; Jaguar V12 and Mercedes 450 SL, PS, Aug. '71] and won't dwell on their engineering details here.

The engineers responsible for these cars have many years of experience with high-performance and "grand-touring" cars. That's one of the cars' secrets—the collective engineering know-how of the technical staffs.

The second secret? Top management of their companies gives the engineers a free hand to build the best possible product without interference from cost accountants. They are not required to use off-the-shelf

parts. If a new engine, new transmission, new steering or suspension system can do the job better, they can go ahead. The penalty for this is high cost.

"Cost" is the answer if you ask why Detroit can't build cars like these. That they need to cost as much as they do is perhaps not apparent when you examine the individual components in each car. But behind each car is an extensive research program without which it could not have been created. That cost must be covered in the price of the car, and since the cars are made in relatively low numbers, it adds up to a lot of money per car.

Thoroughbreds aren't hot rods. They have outstanding acceleration, but would lose a drag race with a hot Corvette or Pantera [PS, April '72]. The design objectives for these cars go beyond that, and place more stress on safety and comfort under a variety of conditions. In addition to our track testing, we drove the cars hundreds of miles on all kinds of roads, from 70-mph freeways to

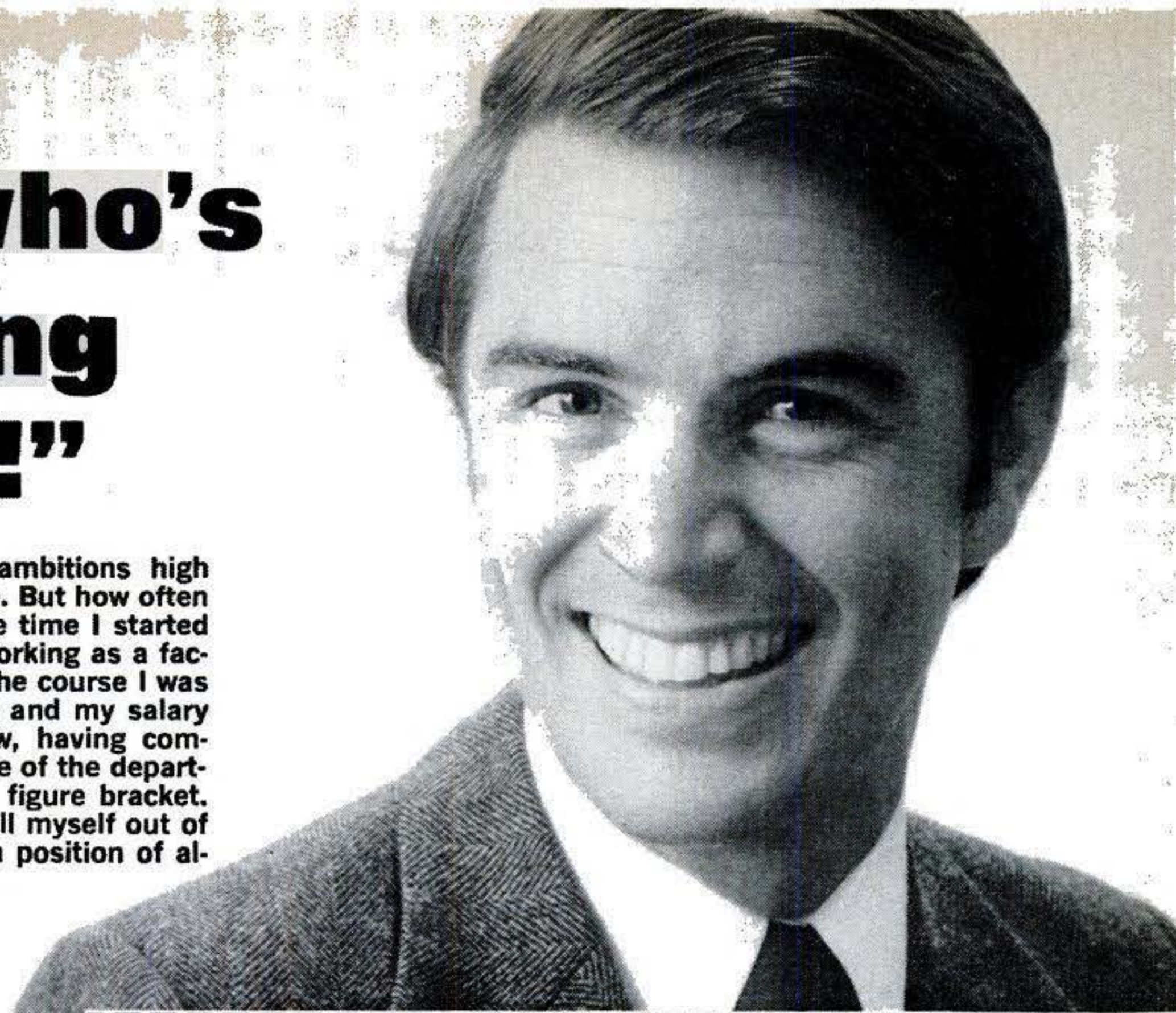
bumpy and winding country lanes.

It's when the conditions get worse that the thoroughbreds impress you most. You can maintain higher speeds in safety and comfort unattained by any other type of car. We had a lot of rain during our test period, and this gave us the opportunity to find out about their behavior on a rain-slick track. In teeming rain we had higher average speeds around Bridgehampton race circuit with the SM and 450 SLC than we can reach with regular American cars in the dry. The Jaguar was poor on wet traction and suffered a lot of wheel-spin, which resulted in tail-wagging and a threat of spinout. But the Mercedes and Citroën could be driven in the rain at speeds close to those they are capable of in dry weather. The result: an extra margin of safety, regardless of conditions.

The grid for our handling test is always the same, for cars of all sizes. It gives an advantage to smaller cars, but we feel it's not realistic to change. Roads do not expand to accommodate wider cars. These cars

"Look who's smiling now!"

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are close to U.S. intermediates in size and weight, and performed the test at speeds 15 mph higher than the average U.S. intermediate. The Citroën SM was a full 10 mph faster than the Grand Am, which is vastly superior to other intermediates. In fact, the only car that has been faster than the SM was the Fiat 128 SL coupe.

The thoroughbreds are also in a class of their own in braking efficiency. The Mercedes stopped with better than 1-g deceleration with cool brakes, and did just as well after warm-up, with stopping distances within inches of each other. The Citroën stopped shorter with heated-up

brakes, exceeding 1-g deceleration (against 0.96 g with cool brakes). The Jaguar brakes deteriorated slightly after warm-up, dropping from over 1 g to 0.98 g.

Fuel consumption was exactly as expected in the SM, worse than expected with the V12, and better than expected in the 450 SLC. All had excellent drivability. None is equipped with add-on emission control devices such as exhaust-gas recirculation or preheated intake air, or have spark timing and carburetor settings so late and so lean that they hurt drivability. Then how do they meet the standards?

Citroën does it with hemispheri-

cal combustion chambers and supplementary air injection. Jaguar does it with combustion chambers recessed in the piston crowns and uniform mixture control. Mercedes does it with Bosch electronic fuel injection and very precise fuel metering. The Mercedes and Jaguar systems bring benefits in gas mileage and power output instead of penalties (as is common with Detroit's emission control devices).

The extreme quietness of the SM on rough roads and its superior ride comfort stem from the oleopneumatic suspension (without metal springs). Mercedes uses rubber

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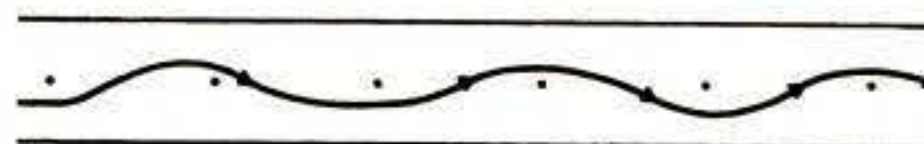
How PS tests brakes—and what the tests show

A car's ability to stop within a 12-foot-wide lane from 60 mph without front wheel locking is measured in PS tests. Rear-wheel locking is kept to a minimum consistent with stopping in the shortest possible distance. The first stop is made with cool brakes to show brake

capacity and balance. Next, PS test team makes 10 warmup stops from 60 mph at one-minute intervals with 0.5-g deceleration. Then another minimum-distance stop is made. Pedal pressure and efficiency are recorded, and stopping distance is measured. The Citroën SM broke

all PS records in the final stop, with hot brakes, coming to standstill in 106 feet (photograph above). The car needed almost 130 feet to stop with cool brakes, mainly due to rear locking (despite the automatic line-pressure control valve on the Citroën's brake system).

PS maneuverability test reveals flaws in the steering system



Driving the car on a snake course between pylons spaced 48 feet apart simulates a low-speed emergency swerve. It's a severe test of the entire steering system (steering ratio, maximum steer angle, front-wheel alignment, and roll-steer effects). Each car makes several runs, progressively faster until its maximum is established. The Jaguar (photo at left) was held back by slow response, vague steering, and strong understeer. Its maximum speed on the course was 27.2 mph. The Mercedes beat that with 29.6, and the Citroën did still better, rolling up a satisfying 30.6 mph.

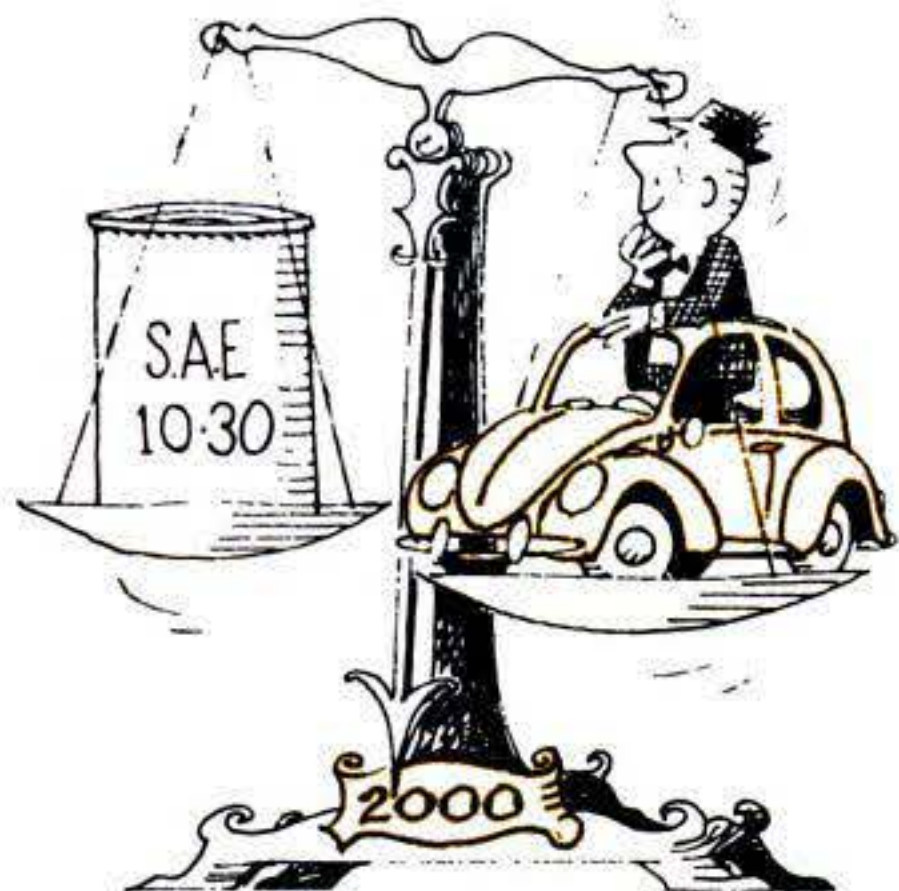
People write to



Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

2 Pounds, Please. In the course of a discussion on drag racing, the subject of weights-per-gallon came up. What is the weight-per-gallon of regular gasoline as opposed to premium grade?

Both these gasolines usually have an API gravity of about 65 (a weight of about 6 pounds per gallon). The difference in the performance of the two is due to their additives and hydrocarbon composition which affect the octane number and have no real bearing on weight-per-gallon.



Underweight? My friend used nothing but 10-weight oil in his car and had no problems to the time he traded it in at 90,000 miles. Wasn't that a little risky? Also, I was wondering if the "weight" of an oil was a reflection of its relative molecular size?

Using a 10-weight oil year-round is living a bit dangerously. This grade oil is thin to start with and will thin out even more with the high temperatures of hard driving. We recommend sticking with the car manufacturer's specifications. "Weight" is not necessarily an indication of molecular size. It is a measurement of the viscosity (fluidity) of the oil.

One for the Road. I can't seem to get the same answer twice. What does "viscosity" mean?

"Viscosity refers to the fluidity or flowing properties of an oil. For instance, SAE 10-weight oils are very thin and have a low viscosity. SAE 50-weight oils are much thicker, like syrup and have a high viscosity. Each oil flows differently because of its characteristics.

Quality Dealers. I recently bought a new Pontiac about the same time a friend of mine bought a new Ford. When it came time for our first oil changes, we noticed both dealerships put in Pennzoil. Do all new car dealers use Pennzoil?

No, not all of them. But many do feel that Pennzoil gives their customers better engine protection.

Changeover. I have 10,000 miles on my car, using another oil and I'm interested in changing to Pennzoil. There's no problem in switching now, is there?

No, there should be no problem. Your car has such low mileage that there should be no accumulation or build-up of residues (if you've been changing your oil regularly). Just ask for the SAE grade of Pennzoil recommended for your car the next time you change oil. Welcome to the family!

Mini-Bomb. I'm taking chemistry at high school and would like to make nitro-methane fuel in the lab. Can you give me the formula?

Because of nitro-methane's highly flammable nature, we strongly recommend that you do not experiment with it. To make it would require high temperature and pressure equipment—a very hazardous operation.



Nitro Burner. I've been racing a gas dragster for a few years now, but have decided to build a fueler. My racing buddies have talked about the big problem with metal-to-metal transfer between pistons and cylinders when you use nitrate juice. I know you're into lubricants for drag racing and are interested in this problem. Could you help me out with some information?

You bet we're interested! The problem is that nitrates have such tremendous solvent power that they strip lubricants from the cylinder walls and tend to promote bearing trouble. That's why we developed Pennzoil Special Racing

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Grease Gourmet. Can I make a multi-viscosity oil by mixing several different single-viscosity oils?

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Phoenix radials on Mercedes (top) have tread pattern with average aggressivity. Michelin XWX tires on SM (center) are highly aggressive; Dunlop SP Sport tires on Jaguar have low aggressivity, near-straight grooves for drainage.



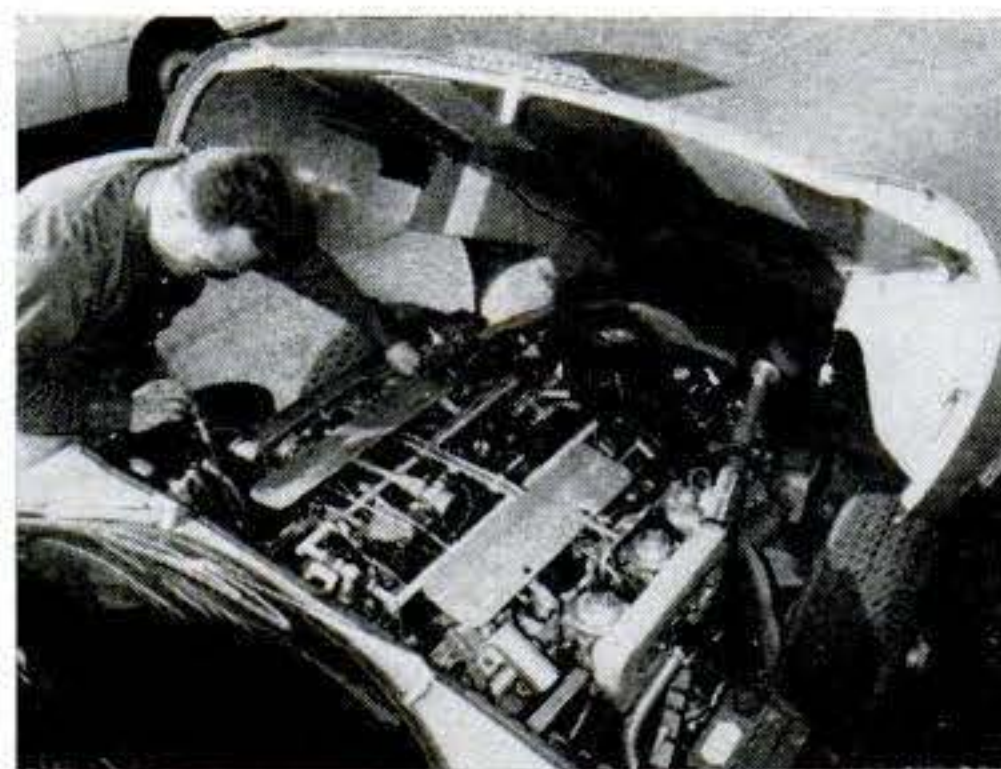
bushings in all suspension links with good results. The Jaguar was noisy, with a harsh ride.

Notes on transmissions. Mercedes-Benz has standardized automatic transmission on all gasoline-powered cars for the U.S. market. The company makes its own automatic—smooth and efficient units with three-speed planetary gearing and hydraulic torque converters. Response to manual shifts is excellent, both up and down, with the floor-mounted lever working in a staggered quadrant.

Jaguar is available with either four-speed manual or three-speed automatic (at the same price). Our test car had the automatic 20/179 Borg-Warner Type 8, which is smooth but disagreeable in use. It often fails to respond to manual downshifts, and sometimes fails to downshift on kickdown.

Our SM had a five-speed gearbox as standard (a Borg-Warner automatic is optional). The floorshift works with remarkable precision—all the more noteworthy since the transmission is placed ahead of the engine, with a rather long linkage. Both fourth and fifth are overdrives. You can almost reach 60 mph in second, and go over 80 in third.

Interiors and instrumentation. They all have standard air-conditioning. The Mercedes has power door locks worked by the key in the driver's door and an optional sunroof. None have power seats; all have manual adjustments and reclining seat backs. On the Citroën it is hinged higher, giving better lumbar support, and the seat cushion can be tilted to vary thigh support.



Jaguar V12 engine is not as hard to service as it may look. Plugs are accessible, with patience, but without special tools. Norbye holds engine dipstick in left hand; transmission dipstick in right. Distributor is maintenance-free, as Jaguar has Lucas electronic ignition.

Mercedes engine compartment is chock full of machinery and accessories. Electronic fuel injection and Bosch electronic ignition are standard. Norbye holds rubber cover over distributor. Plugs are hard to reach, but regular maintenance can be done in normal time.

Front seating dimensions are great in the French and German cars, somewhat cramped in the British product. Backseat room in the SM and 450 SLC is similar to the Javelin's, while the Jaguar backseat is smaller than the Barracuda's. You can carry two persons in the rear for short trips in the Mercedes and Citroën, but not in the Jaguar. Its backseat is useless for passengers.

Power windows are standard on the French and German cars; crank-type are used on the English car.

All have full instrumentation, with large, easily readable speedometer and tachometer. Mercedes and Jaguar dials are circular; Citroën's are oval in shape. The whole panel on the SM has a futuristic look. It is thoroughly padded, but also makes use of brushed aluminum surfaces. A special warning center with a two-inch red light is coded to a double-light system for all vital functions.

Both Jaguar and Citroën have manual chokes—an interesting sidelight on cost-no-object cars. The makers must feel that the cars appeal to buyers who prefer a manual choke. Mercedes-Benz has no choke. Fuel injection gives instant starts, without a fast-idle period, and the V8 can pull under load immediately. Mercedes has a pedal-type parking brake. The others have pull-up handles on the center console. Access to the backseat is easiest on the SM. The seat slides forward while the backrest folds over—and it has a memory so that it returns to the previous setting.

The SM lacks assist straps, and
Continued



Citroën engine is installed aft of the front-wheel axis for ideal weight distribution. Service accessibility is quite reasonable in opinion of PS test team. Norbye holds distributor cap, in front of the three carburetors. Toward the front end of the compartment are hydraulic pumps and reservoirs for the central hydraulic system, which operates suspension, steering, and brakes. Electrical items are also easily reached.

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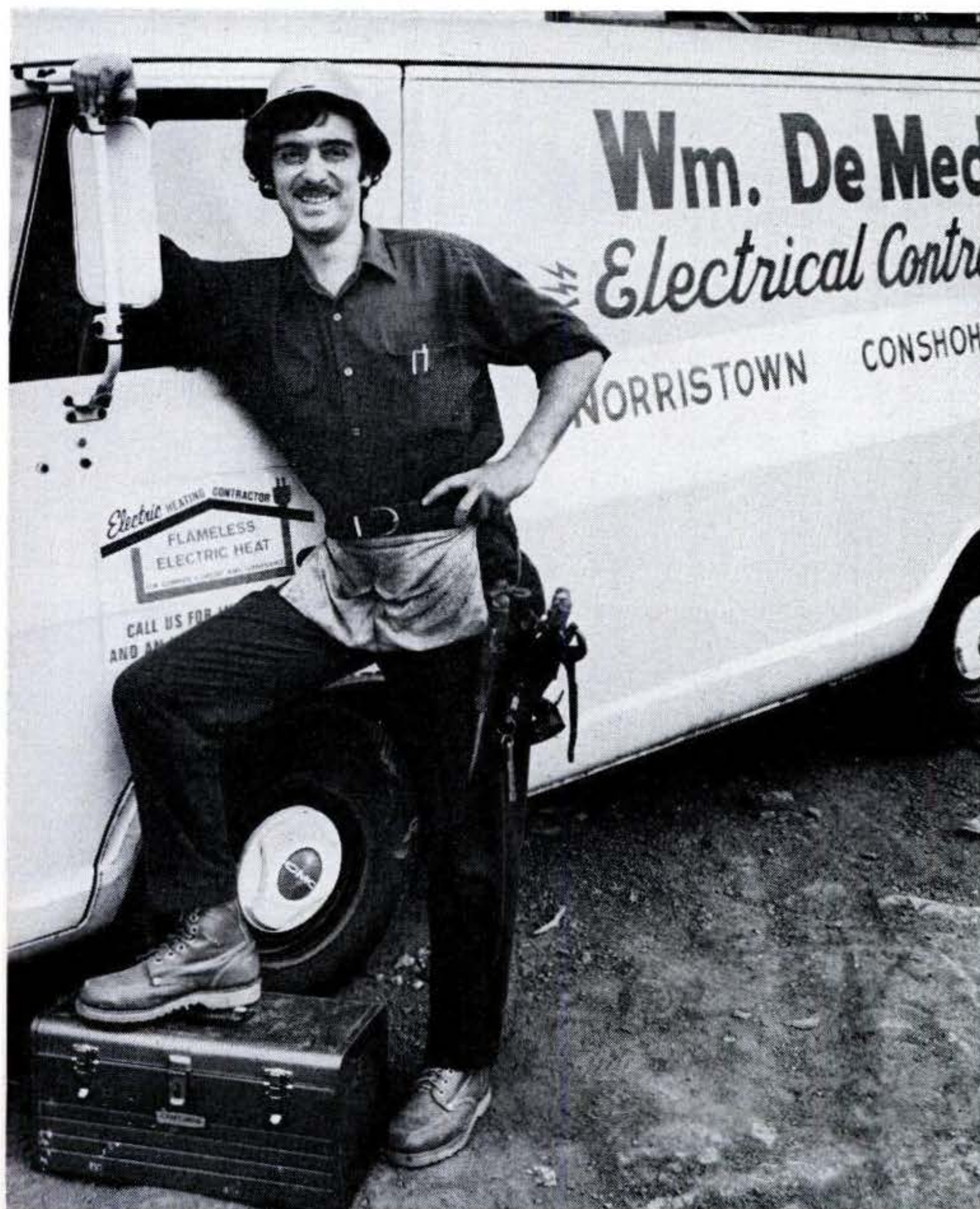
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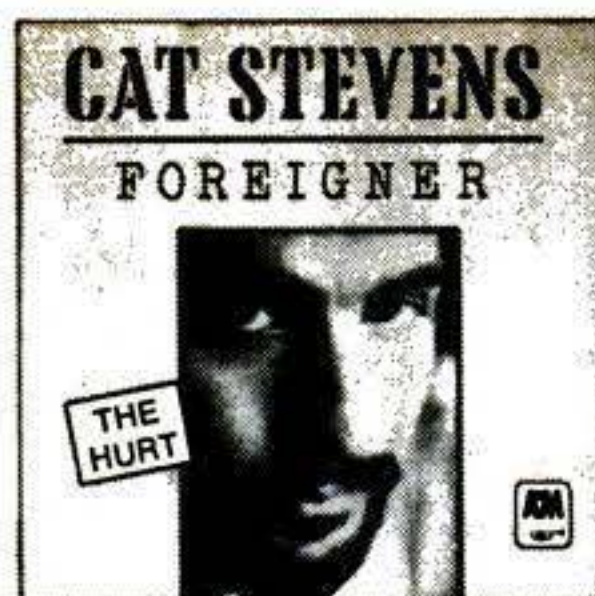
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At 23, Bill De Medio has more freedom, more security, and gets more respect than guys twice his age. (Photograph by Frank Cowan.)



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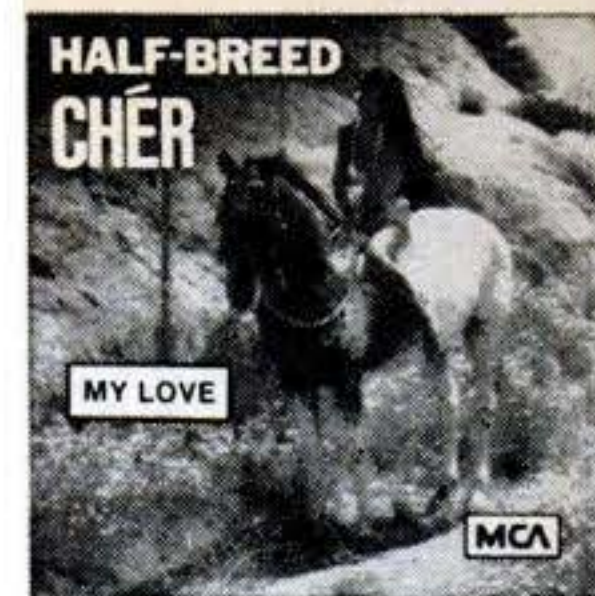
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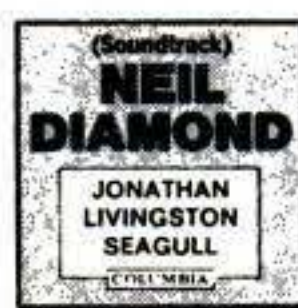
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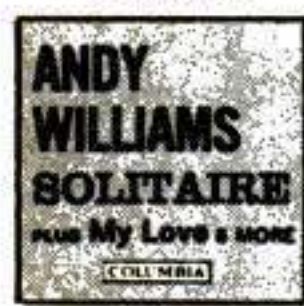
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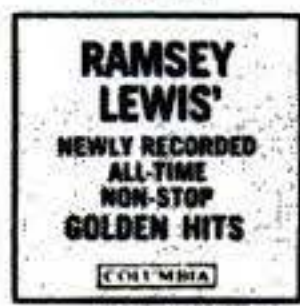
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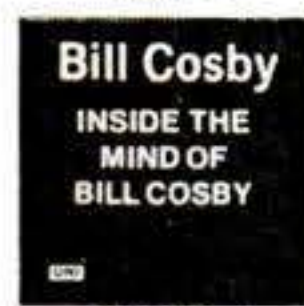
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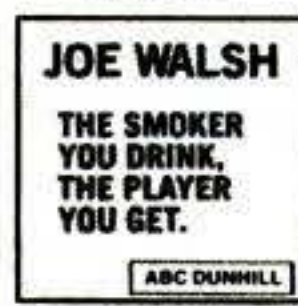
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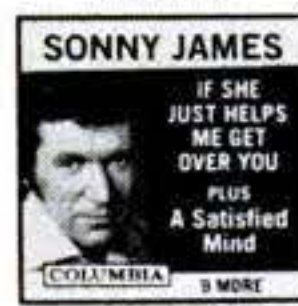
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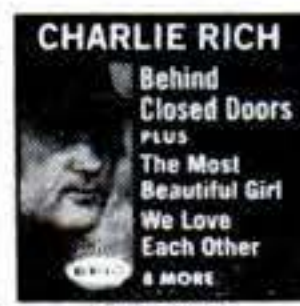
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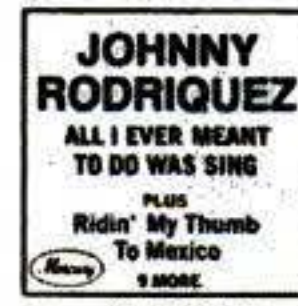
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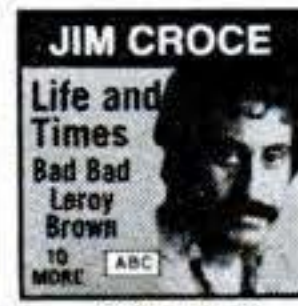
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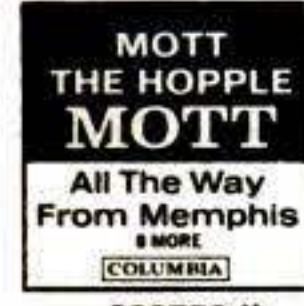
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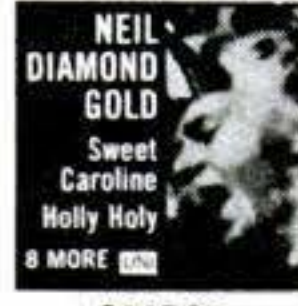
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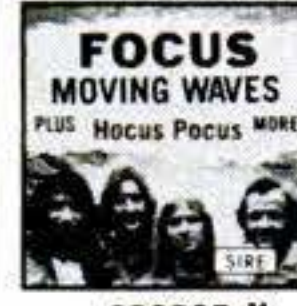
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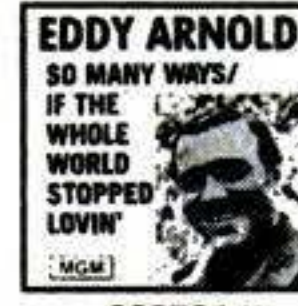
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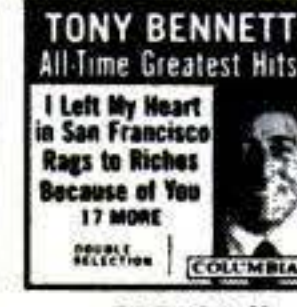
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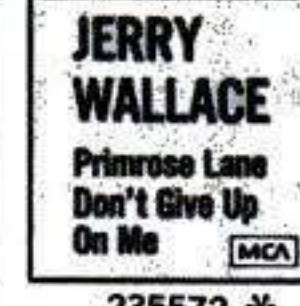
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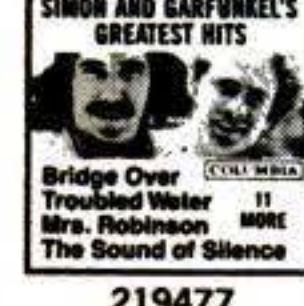
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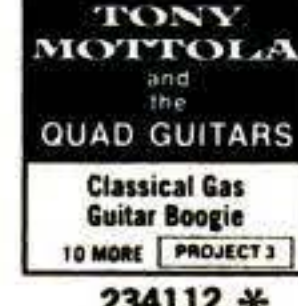
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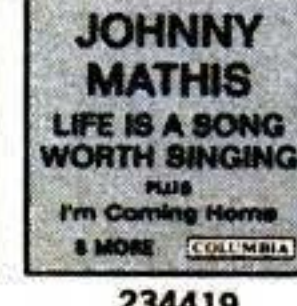
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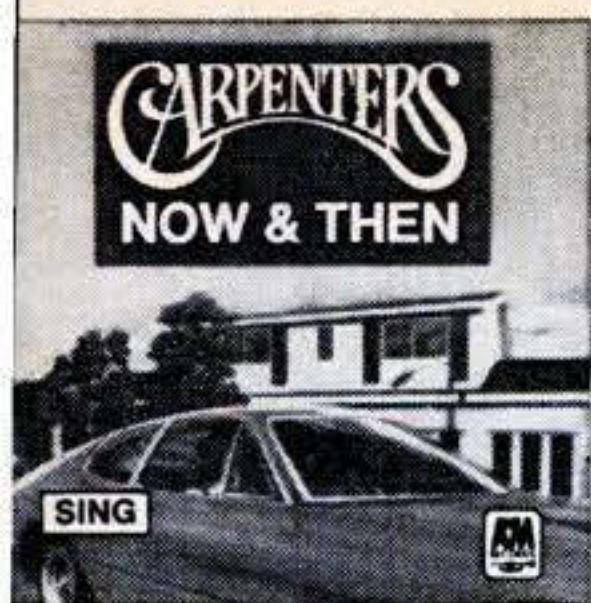
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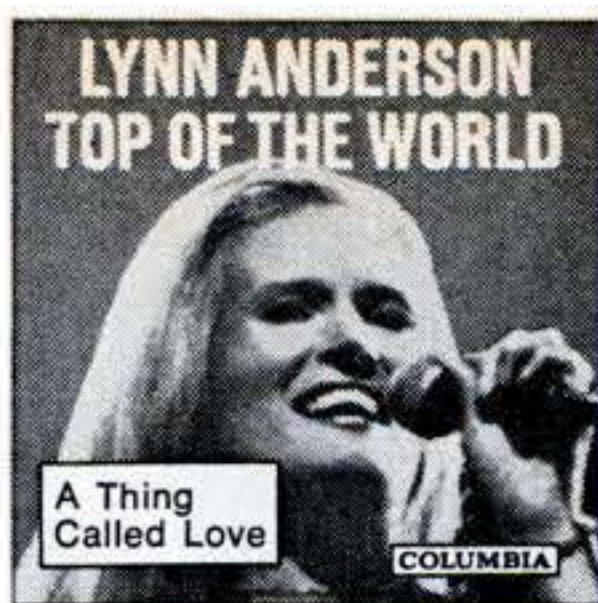
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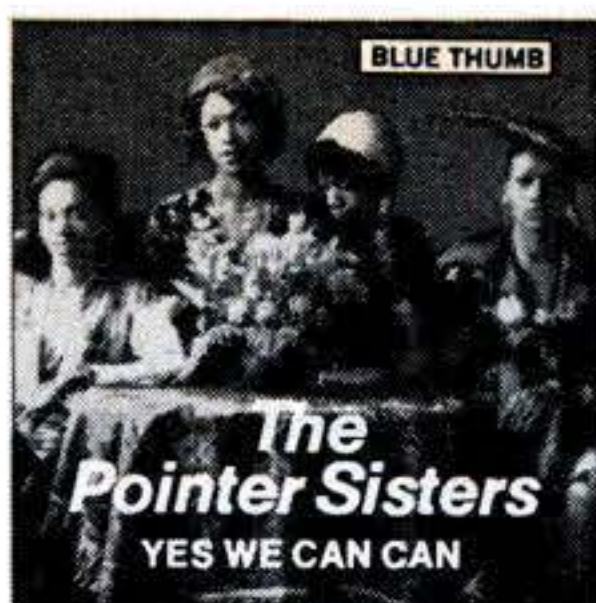
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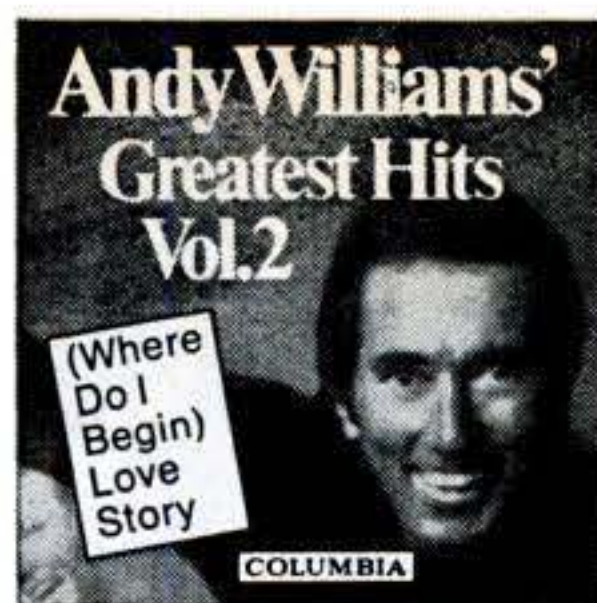
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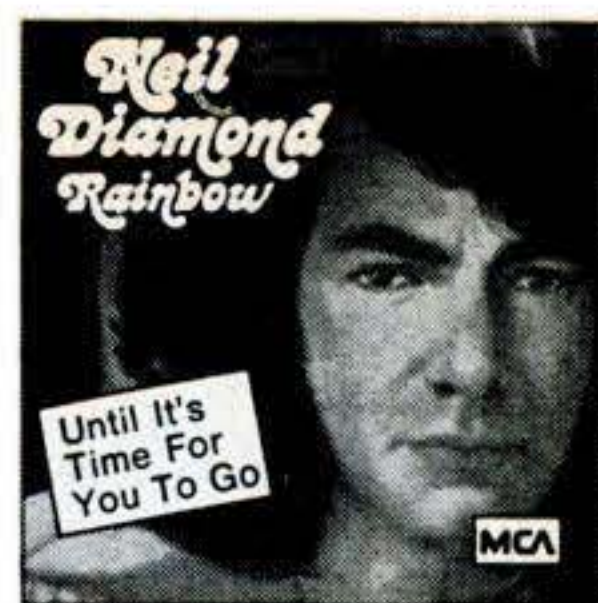
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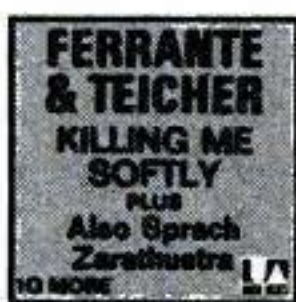
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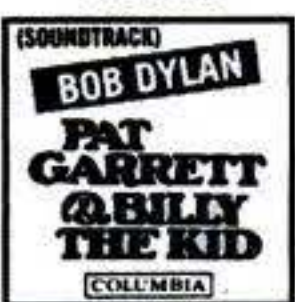
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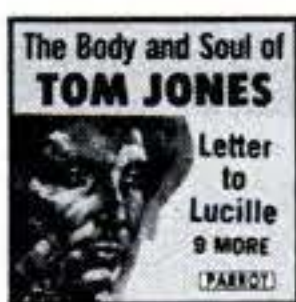
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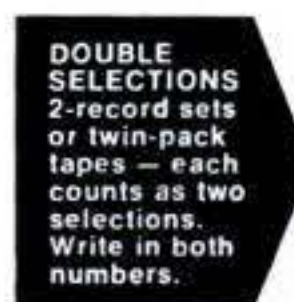
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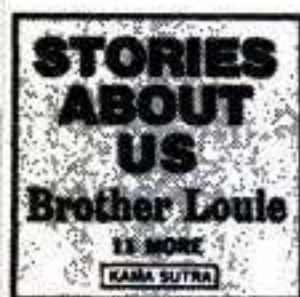
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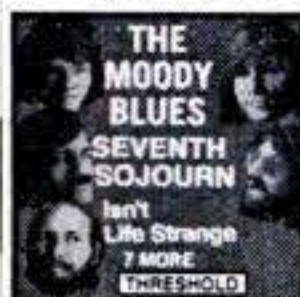
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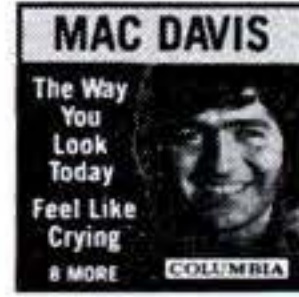
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...if you want any of the other selections offered just order them on the response card and mail it by the date specified.

You will always have at least 10 days in which to make a decision. If for any reason you do not have 10 days in which to decide, you may return the regular selection at our expense and you will receive full credit for it. You'll be eligible for our bonus plan upon completing your enrollment agreement—a plan which enables you to save at least 33% on all your future purchases.

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I am enclosing check or money order for \$1.97 as payment for the 11 selections below. (Include my transistor radio.) Please accept my membership application under the terms outlined in this advertisement. I agree to buy 8 more selections (at regular Club prices) during the coming two years—and may cancel membership any time after doing so. I am interested in the following type of recorded entertainment:

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☐ Mr. ☐ Mrs. ☐ Miss.....
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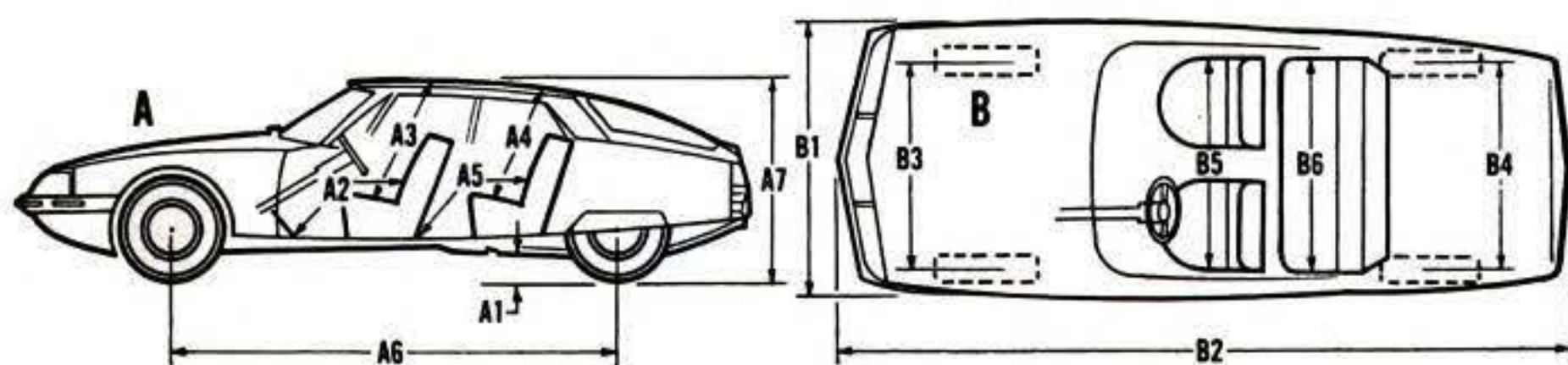


Citroën rear hatch also lifts package tray behind rear seat, giving enormous opening. Trunk is shallow, and loses much space to spare wheel. Rear view is blocked when hatch is open.

Jaguar rear door is hinged on side. Release is inside, unreachable from driver's seat, with secondary latch outside. Opening is small, storage restricted.



Mercedes has boxy trunk of practical shape with wide, flat floor. Spare wheel is housed below; fuel tank is mounted ahead of the trunk, against the rear seat back (for safety).



DIMENSIONS (inches)	Citroën SM	Jaguar V12 E-Type	Mercedes-Benz 450 SLC
A1 Ground clearance	6.1	5.92	5.3
A2 Front leg room (max.)	43.0	45.25	47.0
A3 Front head room	38.0	35.5	38.0
A4 Rear head room	35.0	33.2	33.0
A5 Rear leg room (min.)	33.0	28.0	32.0
A6 Wheelbase	116.1	105.0	111.0
A7 Height	52.0	51.4	52.4
B1 Width	72.5	66.1	70.5
B2 Length	192.5	186.0	186.6
B3 Front track	60.1	54.25	57.2
B4 Rear track	52.2	53.25	56.7
B5 Front hip room	46.0	42.0	52.0
B6 Rear hip room	52.0	33.5	48.0

SPECIFICATIONS

	DOHC V6	SOHC V12	SOHC V8
Engine type	180.9/2965	326/5343	276/4520
Displacement (cu. in./cc)	8.75 : 1	7.8 : 1	8.0 : 1
Compression ratio	3 2-bbl	4 2-bbl	Fuel injection
Carburetion	190 @ 6000	241 @ 5750	190 @ 4750
Net hp @ rpm	188 @ 4000	285 @ 3500	240 @ 3000
Net torque @ rpm	5-speed manual	Automatic	Automatic
Transmission	4.375 : 1	3.31 : 1	3.46 : 1
Final drive ratio	Power	Power	Power
Steering	9.4 : 1	18.0 : 1	17.8 : 1
Steering ratio	Rack & pinion	Rack & pinion	Recirculating ball
Steering gear	2.0	3.5	3.33
Turns, lock to lock	34.5	36.0	33.9
Turn diameter (feet)	Power	Power	Power
Brakes	4-wheel disk	4-wheel disk	4-wheel disk
Brake type	11.81	11.18	10.75
Front disk diameter (in.)	10.08	10.4	11.0
Rear disk diameter (in.)	466.8	448.2	416.6
Swept area (sq. in.)	Michelin	Dunlop	Phoenix
Tire make	XWX	SP Sport	P-110 T1
Tire type	205 VR70-15	E70VR-15	205 VR70-14
Tire size	24.0	20.25	23.8
Fuel tank (gal.)	10.8	9.5	12.4
Trunk space (cu. ft.)	28.0	28.2	30.25
Liftover height (in.)	3306	3514	3687
Curb weight (lbs.)	65.2/34.8%	53.1/46.9%	55.4/44.6%
F/R weight distribution	\$13,350	\$8920	\$17,799
Price (basic)	\$13,350	\$10,135	\$18,795
Price as tested			

TEST RESULTS

Acceleration 0-60 mph	9.3 sec.	9.1 sec.	10.8 sec.
Acceleration 0-80 mph	16.25	15.25	17.3
Acceleration 25-70 mph	10.75	9.75	12.25
Braking (cool) 60-0 mph			
Distance	129.9 ft.	129.5 ft.	116.5 ft.
Pedal pressure	80 lbs.	120 lbs.	45 lbs.
Braking (hot) 60-0 mph			
Distance	106 ft.	144.4 ft.	117.9 ft.
Pedal pressure	61 lbs.	60 lbs.	80 lbs.
Noise level dBA at 60 mph	68	71	67
Handling test max. speed	70 mph	67.1 mph	68.55 mph
Maneuverability, max. speed	30.6 mph	27.2 mph	29.6 mph
Fuel mileage (constant 45 mph)	18.757 mpg	11.718 mpg	17.688 mpg

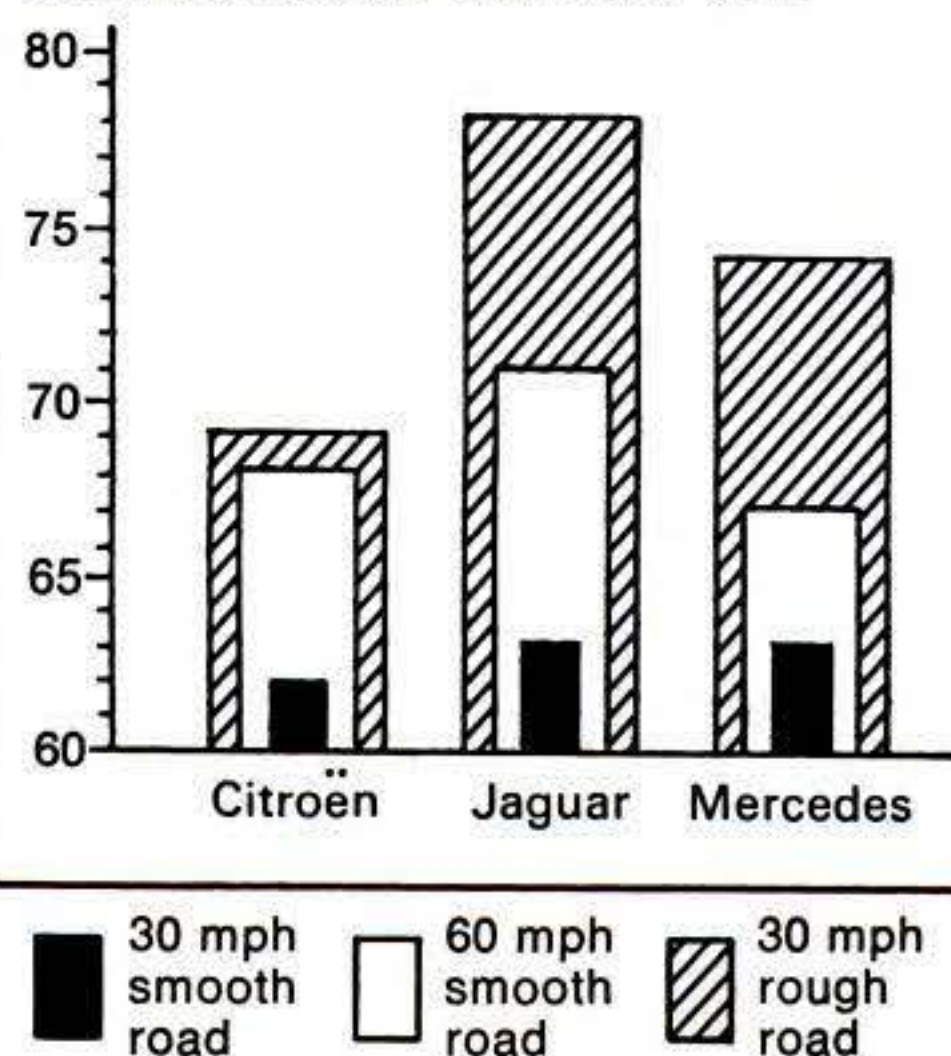
the door handles, inside and out, are unsatisfactory. The Mercedes is ideal in these respects, and also has dual side mirrors of the flip-back type.

The Mercedes-Benz 450 SLC represents the peak of conventional engineering practice, with the added benefit of the company's "think-of-everything" attitude to safety. The E-Type Jaguar is obsolete (except for the engine), and the world eagerly looks forward to its F-Type replacement.

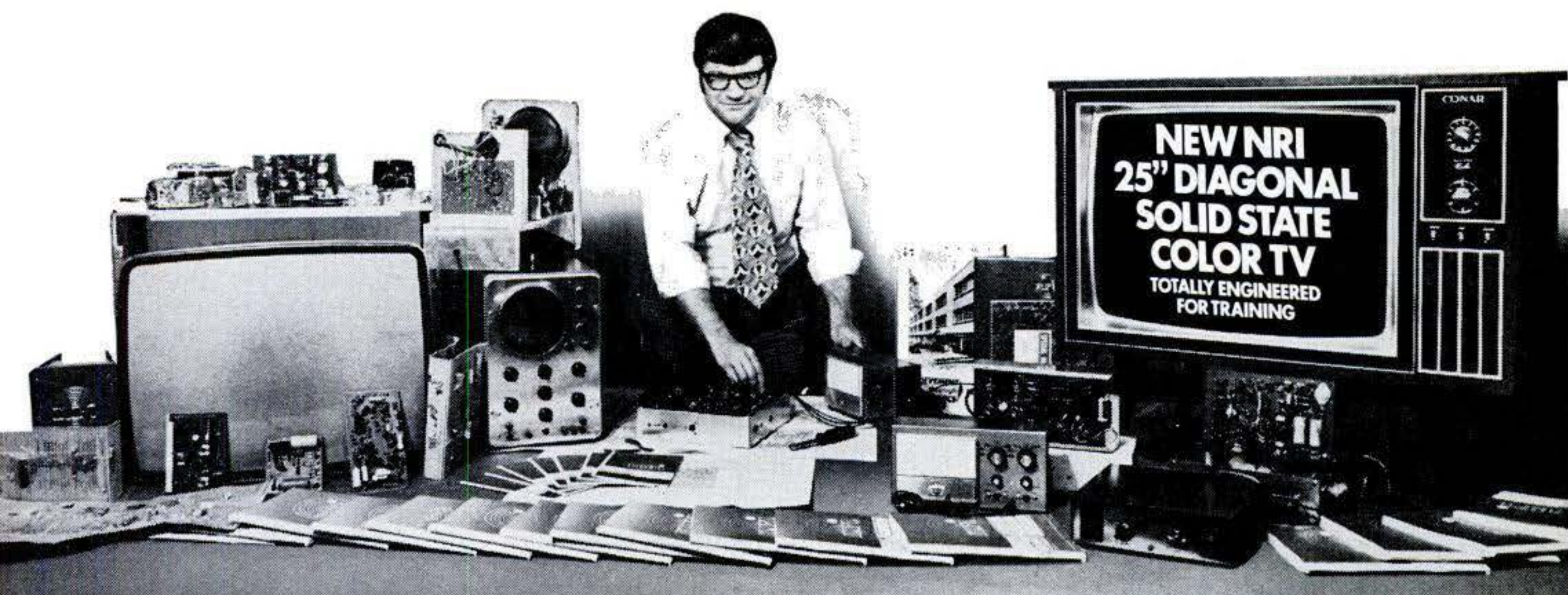
The Citroën SM is the most advanced production car in the world, and will no doubt become a trendsetter in its class. It is a whole new driving experience, after which it is difficult to be satisfied with any other car on the road. **PS**

NOISE-LEVEL TESTS

Interior noise is measured in decibels on the A scale on our standard General Radio sound-level meter applied under three sets of conditions. A reading of 50-dBA is like an average residence. A 60-dBA reading is like a large store; 70-dBA, like a freight train going by 100 feet away; 80-dBA, like a pneumatic drill at 50 feet.



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Science Newsfront

Last-minute news and notes to keep you up to date By ARTHUR FISHER



New scanning electron microscope technique improves resolution

Scientists at the IBM Thomas J. Watson Research Center have boosted the resolution possible with a scanning electron microscope (SEM) by at least three times, to better than 30 angstroms (an angstrom is a ten-millionth of a millimeter). They place a specimen *inside* the scope's magnetic lens, permitting a much narrower scanning beam. The picture above, made with the new technique, shows a layer of silicon dioxide (right) 3000 angstroms thick. Magnification is 200,000 times.

Sodium-sulfur battery

Since the appearance of our story on new battery research [PS, Oct. '73], battery news just keeps on coming. Now the Edison Electric Institute has given General Electric a



contract to develop a sodium-sulfur battery for bulk energy storage, to meet peak electricity demands and avoid "brownouts." The battery (you see one cell of an experimental model here) could theoretically store five times as much energy per pound as conventional lead-acid batteries.

Sodium-sulfur batteries use liquid sodium and liquid sulfur separated by a ceramic solid electrolyte and operate at 300 to 350 degrees C. Previous efforts have foundered on the breakdown of the ceramic separator, which GE hopes to overcome.

Hydrogen injection engine

Is it possible to design an internal combustion auto engine that will 1) meet the very rigorous 1977 emissions standards, 2) improve fuel economy, and 3) avoid the expensive and perhaps short-lived catalytic converter?

NASA has come up with one of the most exciting "maybes" we've heard yet. It's a revolutionary new

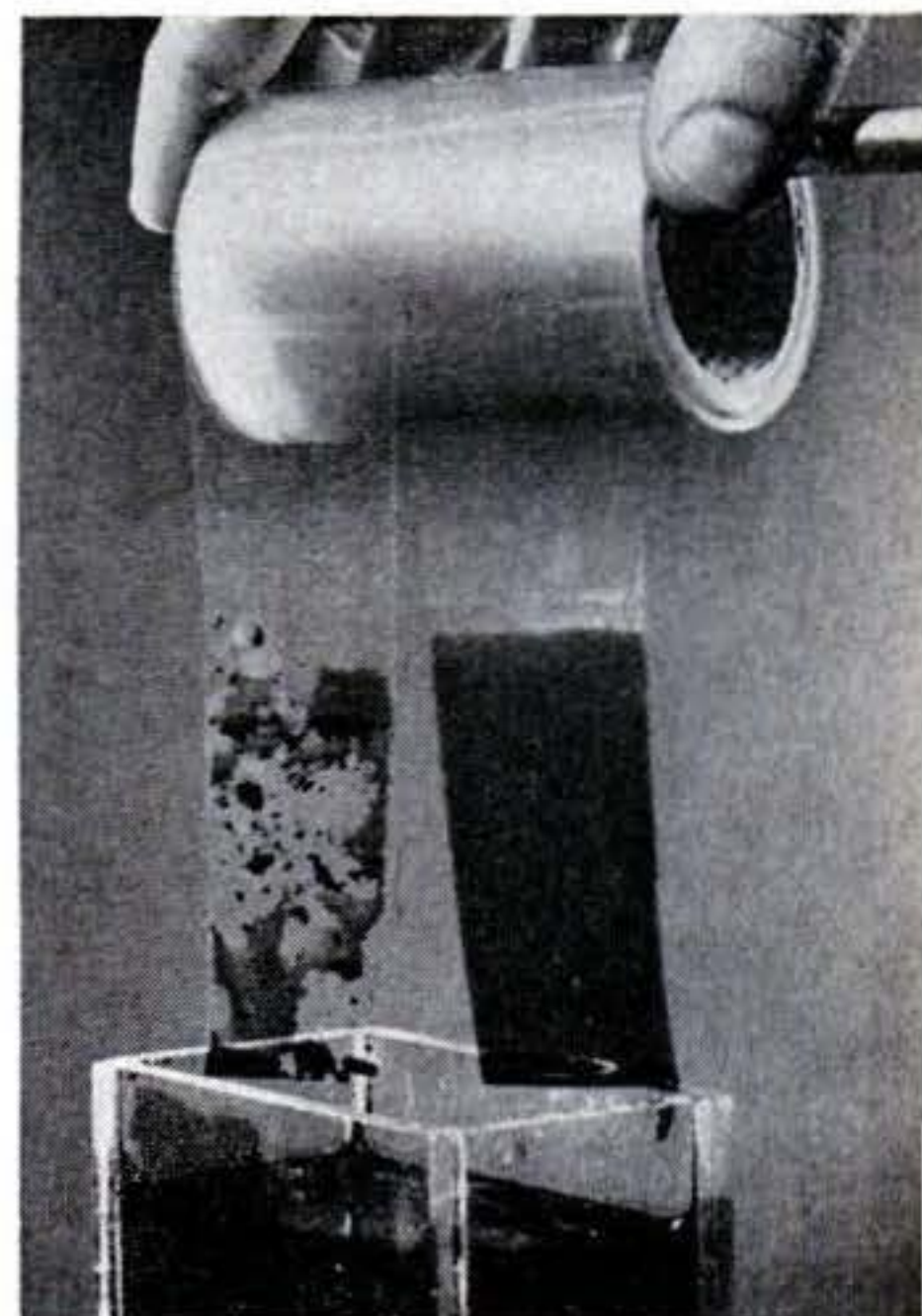
system of hydrogen injection in a modified form of the conventional i.c. engine, based on 3½ years of research at Jet Propulsion Laboratory. The agency has purchased two Chevrolet four-door sedans for installation of what has until now been a laboratory system, and NASA engineers hope that within two years a vehicle able to meet '76 or '77 standards will be running.

The new combustion system would run on a mixture of hydrogen gas, air, and gasoline vapor (or even cheaper petroleum products or synthetics). The hydrogen will come, not from a tank of gas, as in previous hydrogen car concepts, but from an on-board hydrogen generator, where water vapor will react with burning gasoline and air. (A water tank will carry about five gallons of water for every 15 to 20 gallons of gas.) When the fuel mixture is burned it will yield an exhaust that is nearly all water vapor and inert components. Moreover, gasoline consumption should be significantly decreased.

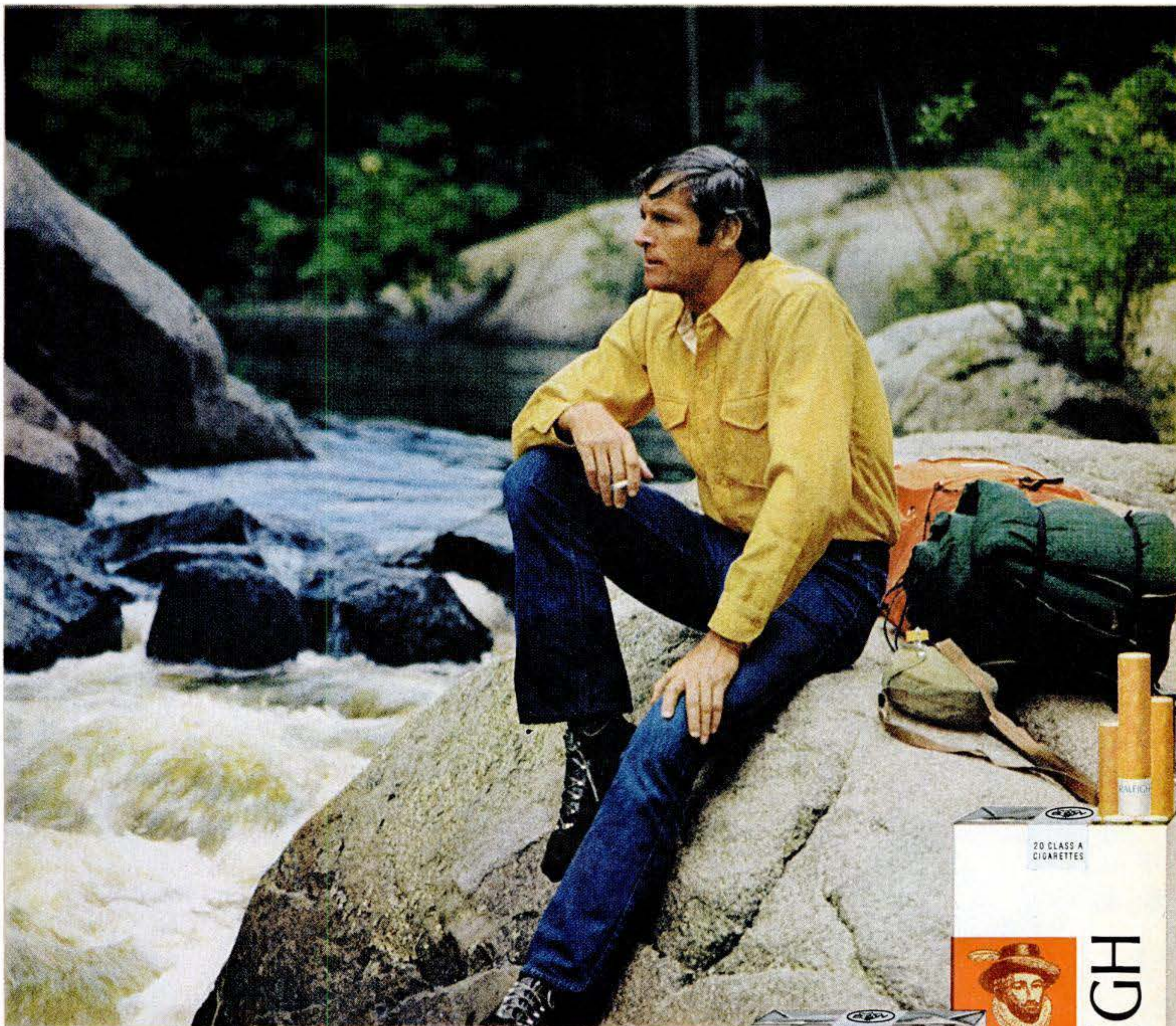
To begin with, one of the cars will be operated with bottled hydrogen gas, until the hydrogen generator is developed and can be installed. NASA also plans to test the system in aircraft later.

So wettable it's inconvertible

The strip at left represents a nasty problem for chemists—a material, such as polyethylene, that is water-repellent and thus resists being treated with a nice, even, chemical coating. But the right-hand strip demonstrates a solution. It's the same material specially prepared to make it perfectly wettable. The secret was developed by Dr. John T. Kenney, a chemist at Western Electric's Engineering Research Center.



It is to dip the reluctant material in a suspension of metal-oxide particles, which deposit to form a new, permanent, and completely wettable surface.



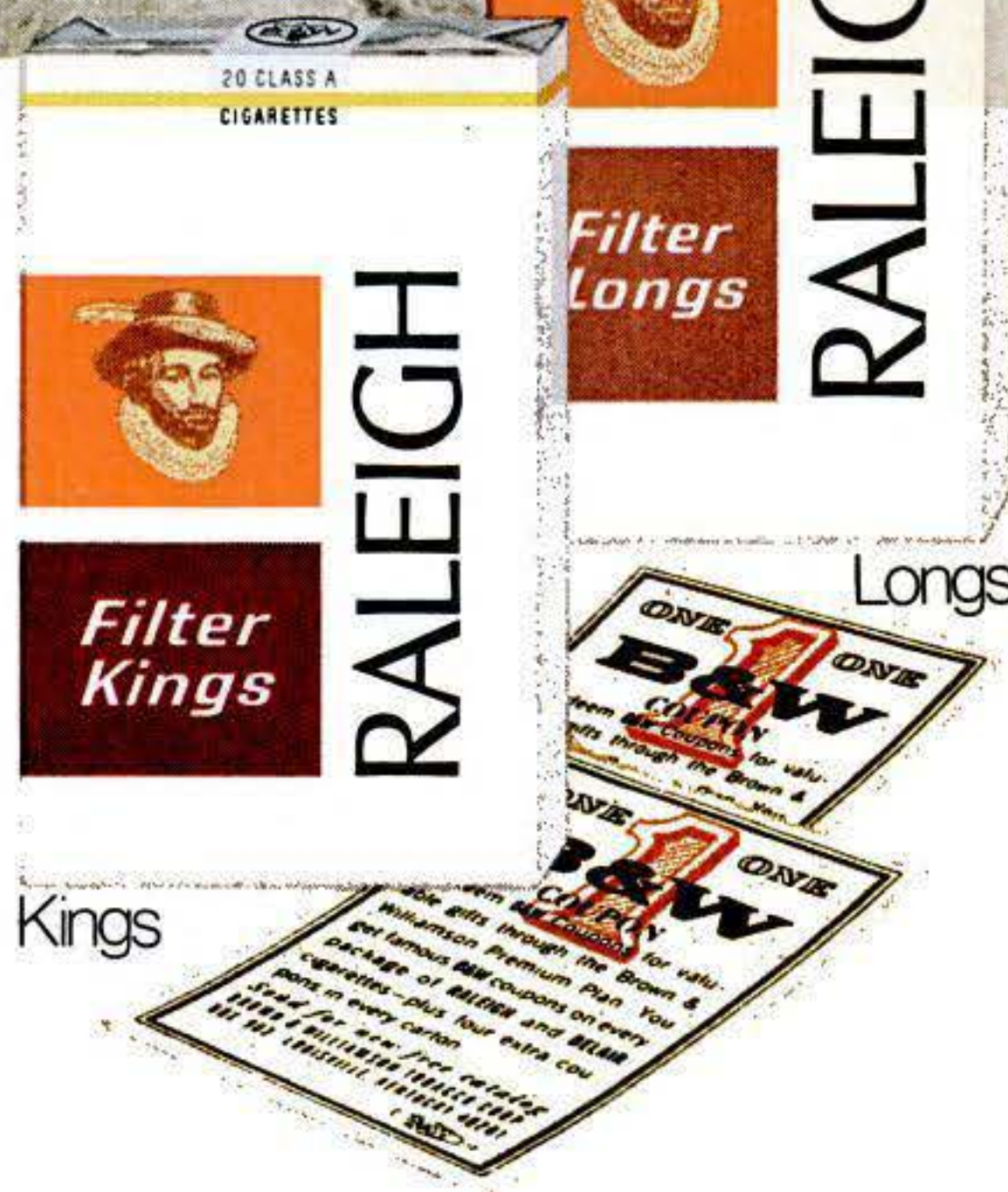
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Filter Kings, 16 mg. "tar," 1.2 mg. nicotine; Longs, 18 mg. "tar,"
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That Cigarette Smoking Is Dangerous to Your Health.

AMC  GREMLIN

RELIEVE THE FUEL SHORTAGE

AMC Gremlin is the only U.S. sub-compact with a standard six-cylinder engine. Yet for all its engine, the car is very easy on gas. Averages over 18 mpg, depending upon the way you drive. And Gremlin still out-accelerates, weighs more, has a wider track, wider front seat, and wider back seat than any other car in its class. If you want to know what else Gremlin relieves, price one.



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Wave a card
near your
door...
and presto!
It opens

This Lock Makes Your Keys Obsolete

By RICHARD STEPLER

It's dark and raining, you're loaded with packages, and you're standing at the front door fumbling for your key. Sound familiar?

That could be a scene of the past with a new electronic lock that has neither key nor keyhole. It gives you both convenience—just hold a card near the door to open it—and security—it's pickproof because there's nothing to pick.

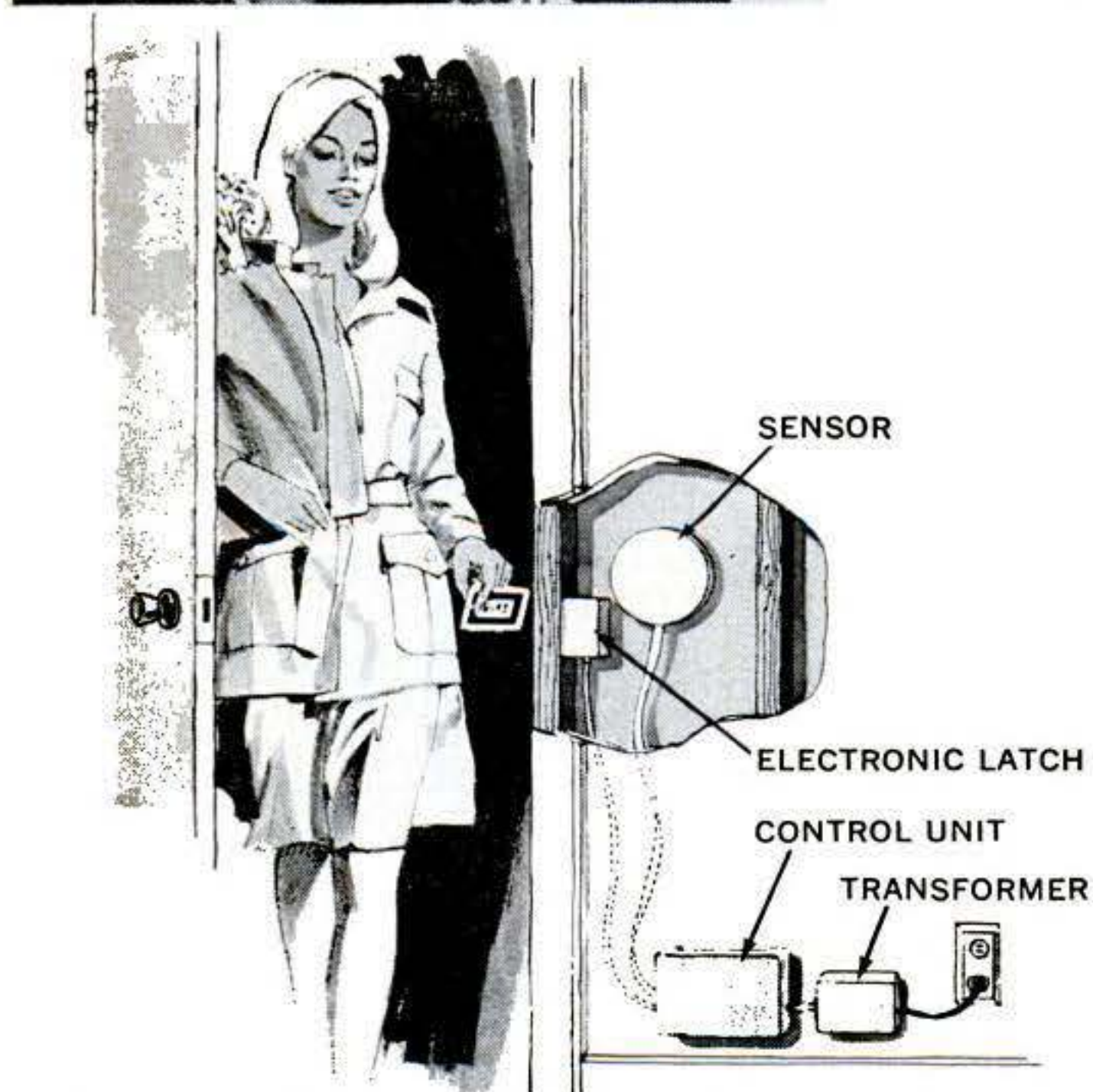
Electronic locks themselves aren't new. What's new about this one is that it doesn't use a magnetically encoded card and there's no card slot. In fact, from outside the door, the entire unit is invisible.

While it sounds mysterious, there's nothing that unusual about the lock, technically. The sensor, in effect an inefficient radio antenna, continually emits a cascade of radio frequencies in the four- to 16-MHz range. When the key card, which contains a passive resonant circuit, is brought within four inches of the sensor, it absorbs radiated energy from the sensor at a given frequency and causes a drop in signal amplitude at that frequency.

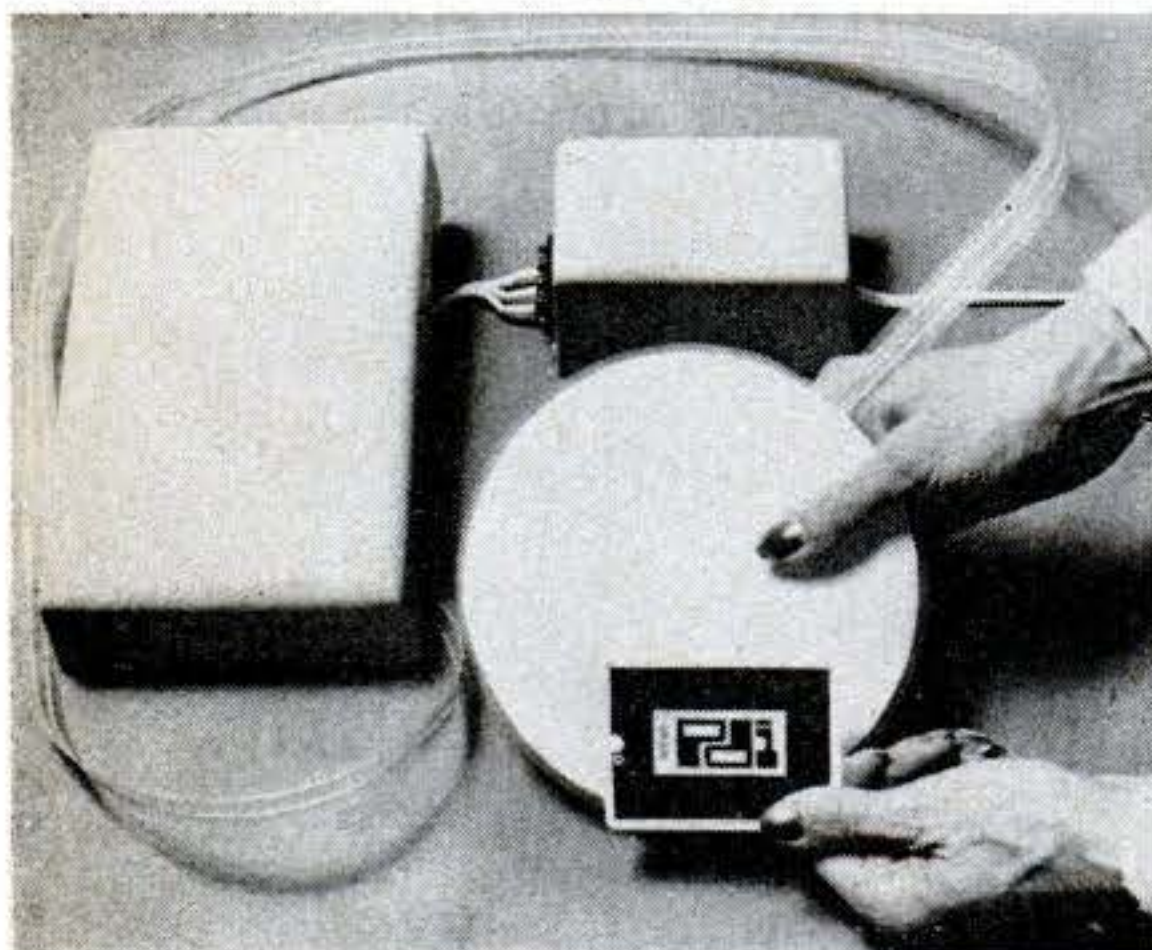
The reference card in the control unit is also scanned. A logic circuit in the control unit compares the two drops, and if it decides they match, the door opens, usually by relay to an electric door strike or solenoid-actuated bolt. If they don't match, the system can trigger an alarm, or it can lock up for 30 seconds to 60 minutes. This makes it virtually impossible to electronically pick the lock.

The PDI Access Control System is the invention of Charles Walton, president of Proximity Devices, Inc., Sunnyvale, Calif. It's made and sold by Schlage, the San Francisco-based lock company. Present cost is high: \$300 for a one-door system, \$650 for a four-door central system. Walton, however, predicts that mass production will make the lock competitive with conventional locks within just a few years.

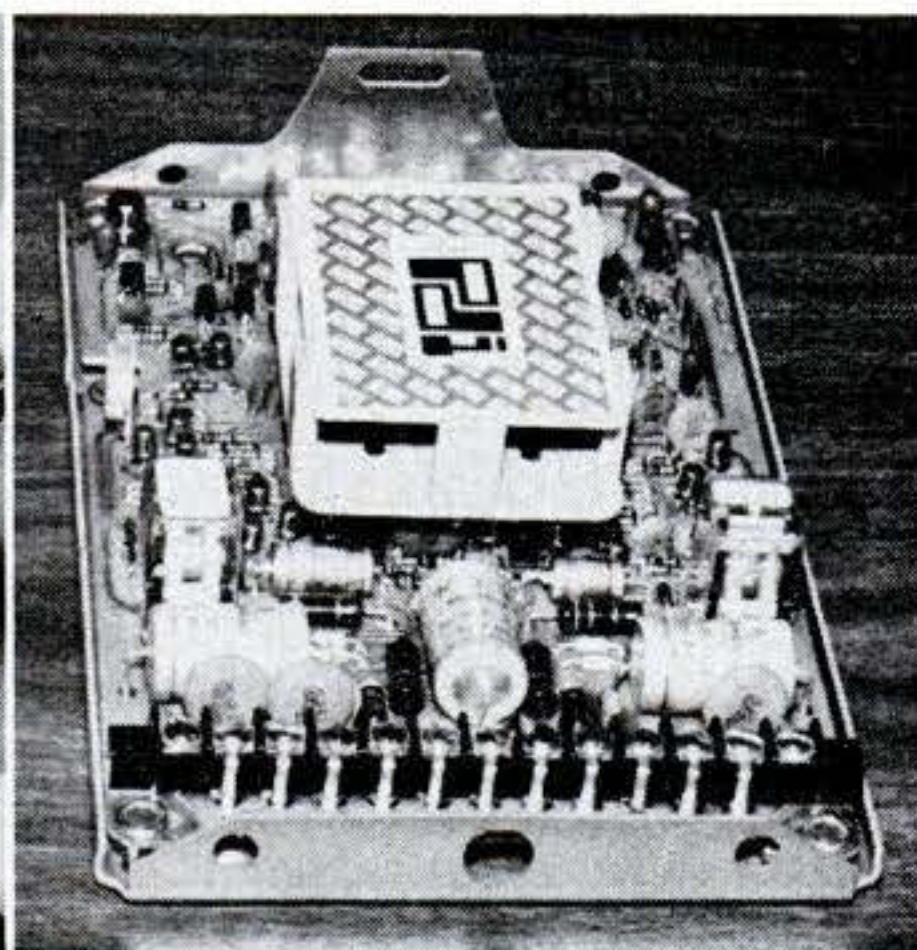
P 5



No hands are needed to open the door—just hold the key card near sensor. You could even do it with the card in your pocket. Typical setup (left) shows sensor mounted inside wall—only you know exact location. The sensor is connected to the control unit, which runs on house current via transformer. Control unit signals electric latch to release door—or in case of tampering or use of wrong key it can activate lights, doorbells, other alarms, or send a signal to a remote security alarm.

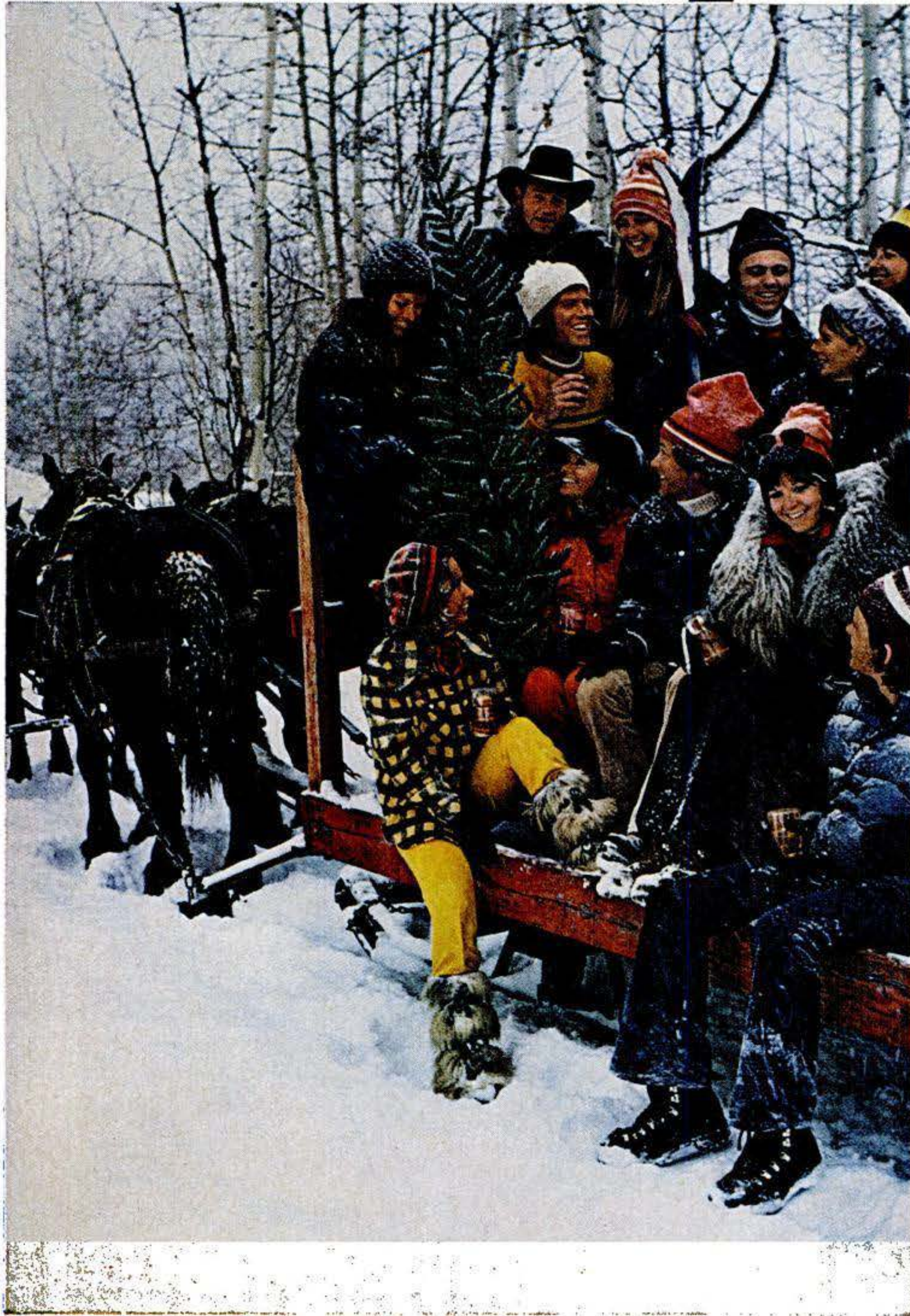


Basic components: control unit (left), transformer (top), sensor (six-inch disk), and key card. There are 10,000 key codes now; changing frequency range adds more.



Reference card is visible in control unit with cover removed. It has same circuitry as key card. To re-key lock, insert new reference card.

Share America's Whiskey.



When you head out for a Christmas party in the country, sometimes you find the roads aren't plowed.

Sometimes you find there aren't any roads.

But no matter. A little snow won't hold you back. Not when the lodge is just around the bend. Where the fire is crackling, and a turkey's turning on the spit.

It's a time when old friends make new friends, and everyone shares the joy of the season.

It's a time when all over America, people share the friendly taste of Seagram's 7 Crown. Not only as a gift, but in the holiday drinks they serve.

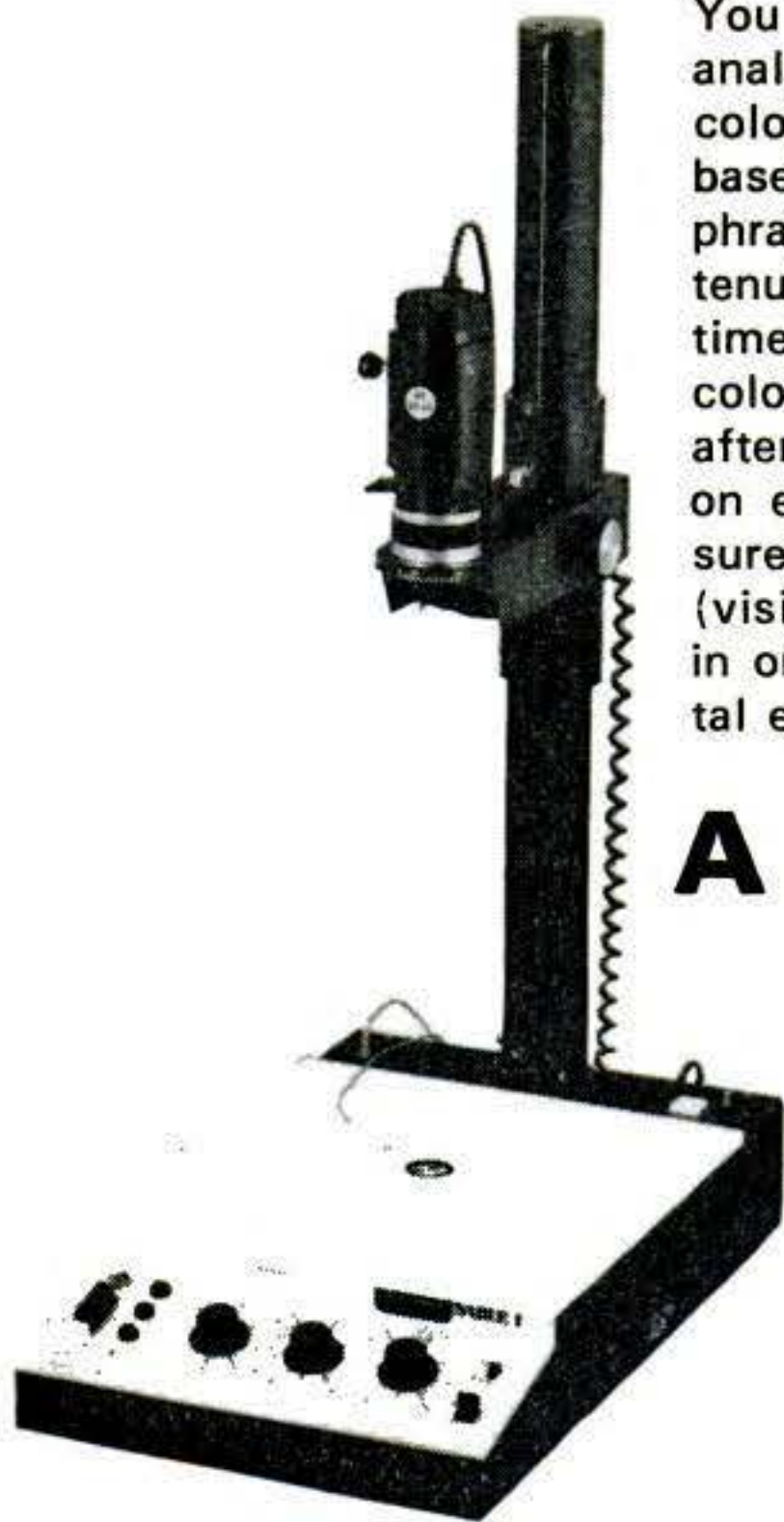
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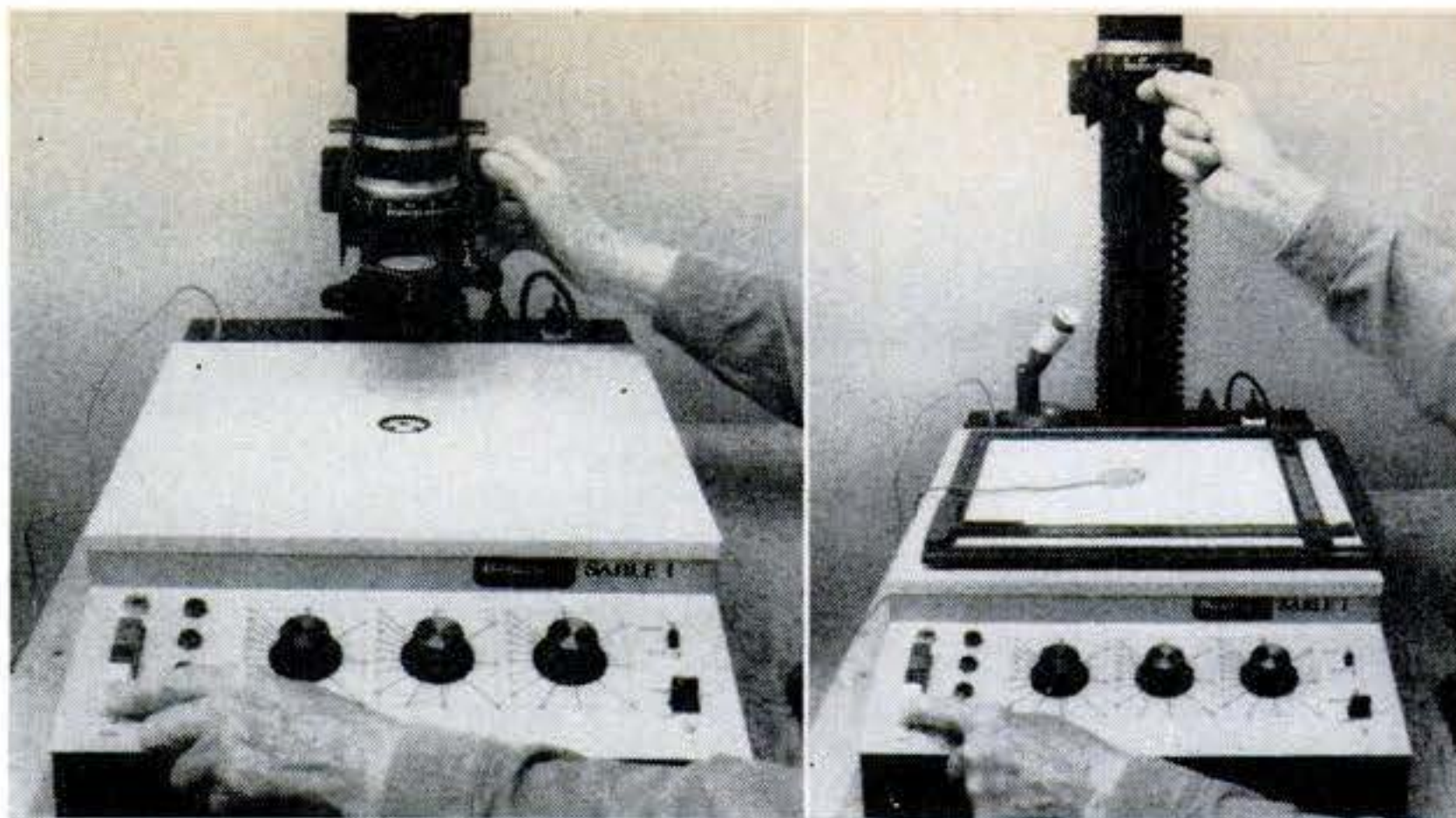


PERSONAL-USE REPORT



Sable 1 Color Printer has all controls (except lens) in base console. Three timers start simultaneously but end individually, releasing filters into the light path to terminate, in order, blue, green, and red exposures. Enlarger lamp is then turned off, safelight turned on.

Programing the Sable 1: You press buttons, machine analyzes negative's primary colors through photocells in baseboard, with lens diaphragm used as a light attenuator. Dials set separate timers for each of the three color exposures. At right, after image has been focused on easel, brightness is measured with exposure probe, (visible in center of easel), in order to determine the total exposure for the print.



A Pushbutton Color Printer

There's a new machine in my dark-room these days that makes color printing pushbutton-easy. It's the Sable 1 Color Printer, an almost automatic enlarger-plus.

Sable 1 incorporates everything needed for analysis and exposure in a single integrated unit: color and exposure analyzers, three super-accurate timers, voltage stabilizer, filter pack, room and safelight controls, plus a fine 35mm enlarger with an El-Nikkor 50mm f/2.8 lens.

In use, the machine functions first as an averaging color densitometer to make an integrated color analysis of the negative, and programs the

correct times for the three color exposures. Then, using an exposure probe (photocell) to measure image illumination in a shadow area, you set the lens aperture. A single switch initiates automatic filtration and exposure sequence.

The machine can also be used, of course, to make black-and-white prints. Accessory negative carriers adapt it to half-frame 35 and 126.

Developed by Sable Photo Works, Inc., Boulder, Colo., Sable 1 is marketed by Honeywell Photographic Products, Box 1010, Littleton, Colo. 80120. Price: about \$600.—*Paul Wahl*

PERSONAL-USE REPORT

Castamatic—Easy Unreeler

A one-handed spinning reel has always escaped our grasp. Several have claimed it; now this one does it. Where conventional spin-fishing reels need a forefinger to hold the line while you open the bail with the other hand, the Castamatic lets you complete the cast with one hand—and without touching the line.

On the water I found it can perform faster, easier, and with neater casts since line is released by the bail rather than by a sticky finger. In a day's fishing I had fewer tangles, even fished with gloves on.

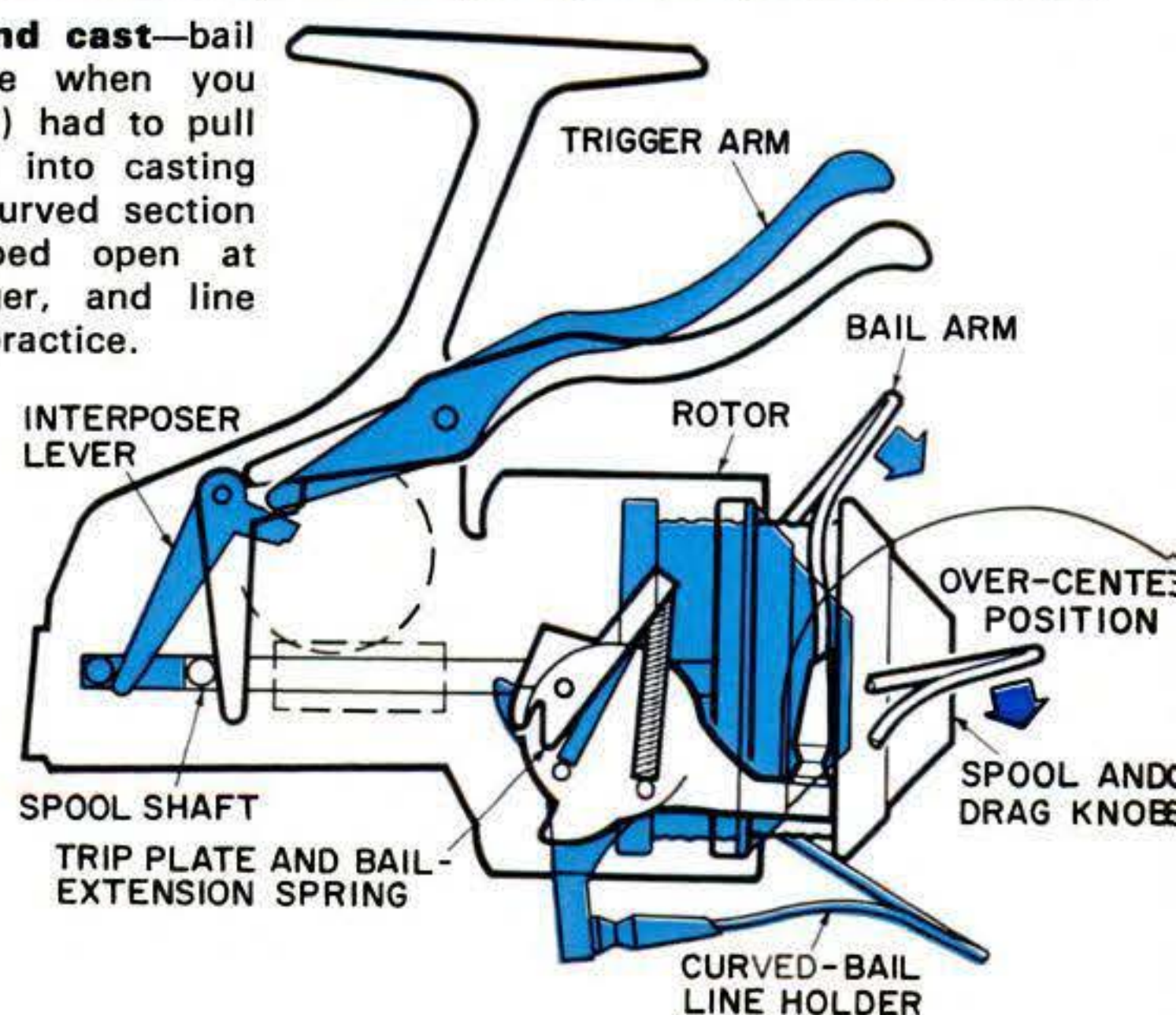
The ball-bearing bail arm is extremely free-moving on command, designed to eliminate a partially closed bail caused by binding sheet-metal parts. You can open bail in any rotational position, and crank backwards in the open position.

But it takes practice—it's that quick timing of the line release that beats the finger. Made by Berkley, Spirit Lake, Iowa 51360, it's a good buy at \$25.—*Dave Vigren*



Just pull the trigger and cast—bail automatically releases line when you relax finger. Author (above) had to pull trigger hard to move bail into casting position (line is held by curved section of bail). Then bail flipped open at moment he removed finger, and line shot out cleanly. It takes practice.

How it works: Squeezing trigger moves interposer lever that pulls spool shaft back against bail extension-spring anchor point. This puts bail arm in over-center position, flops bail open when trigger is released. On your first rewind turn, the trip plate hooks bail arm, closing the bail.



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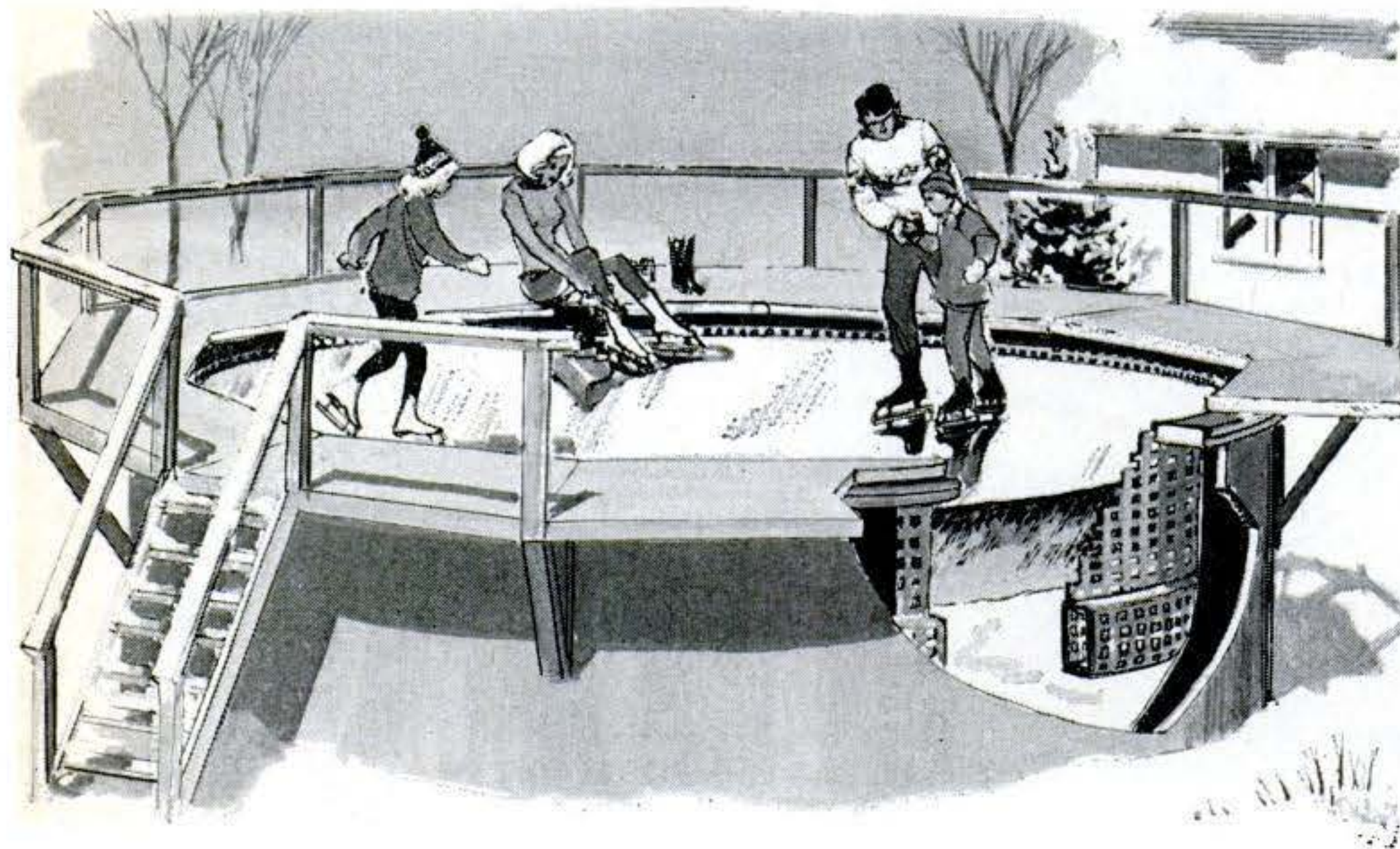
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New Ideas from the Inventors

The PS pick of ingenious inventions recently patented

ILLUSTRATIONS BY DANA RASMUSSEN



Liner-shield kit converts pool to ice-skating rink

Formed as segments of a circle, these sturdy plastic shields would slip over the rim of a conventional above-ground swimming pool to form a protective facing inside the liner. Turned-in flanges at the lower ends of the shields would space the protectors from the pool wall. Supplied as a kit, the segments would lap and attach to each other to form an inner pool in which water could freeze for skating without cutting the regular liner. The shields would also buffer the regular, more fragile pool wall against skate-impact damage.

Flashlight aims chemical spray



A guard or policeman could see exactly where he was aiming an aerosol spray if it followed the beam of his flashlight. Attached behind a regular flash and triggered from a hand grip, this anti-intruder or riot-control chemical could be discharged accurately and quickly while leaving one of the watchman's or officer's hands free.

Third wheel improves cycle drive



Tandem driving wheels would give this cross-country cycle safer, surer footing on rough terrain. Linked to a drive sprocket by parallel bolsters, the wheels would rise and fall independently, keeping one wheel in contact with the ground when the other was bouncing over a hole or bump. It's said to cut up-and-down frame movement.

Scraper limits brush dip

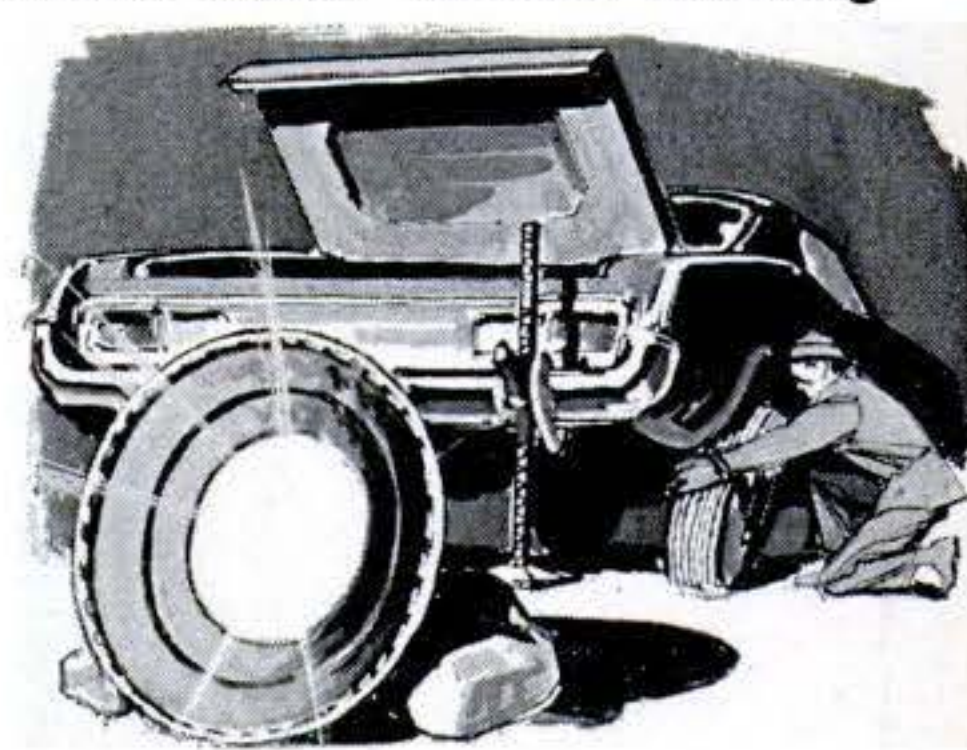


Lowered inside a paint can, this adjustable platform could be set by tightening a thumbscrew on a rod. It would preset and limit the dipping depth of a brush to keep the ferrule clean. An angled, upright scraper would let you remove excess paint from the bristles, drain it back into the can instead of running it around can's resealing lip.

Voice switches TV camera

Closed-circuit television conferences could be improved, according to this Bell Labs patent, if individual cameras were switched on by a speaker's voice. The speaker would then be seen and heard by conference participants at all locations. And when the speaker changed, a different camera would be activated. The leader could override the voice switches, when needed, to display graphic materials.

Wheel cover flashes warning



Light-reflective patches inside your hubcaps or wheel covers could make flat-changing safer for you and for other drivers. Set on or off the road at a reasonable distance from your car, the reflector would shine a warning from light of an approaching car's headlights. The hubcap could be propped on a special stand or held up by a rock.

The following patents have been issued on these inventions:

Pool-to-rink kit—No. 3,639,921 to W. Siler, Toledo, Ohio; Flashlight spray—No. 3,638,836 to C. Vickers III, Jacksonville, Fla.; Three-wheel cycle—No. 3,638,746 to L. Gostomski, Thorp, Wis.; Brush scraper—No. 3,641,615 to C. Peasley, Burlington, Mass.; Voice switch—No. 3,601,530 to R. Edson, Brielle; D. Mitchell, Martinsville; and G. Reid, Holmdel, all of N. J.; Safety hubcap—No. 3,639,036 to E. Rosebach Jr., Abington, Mass.

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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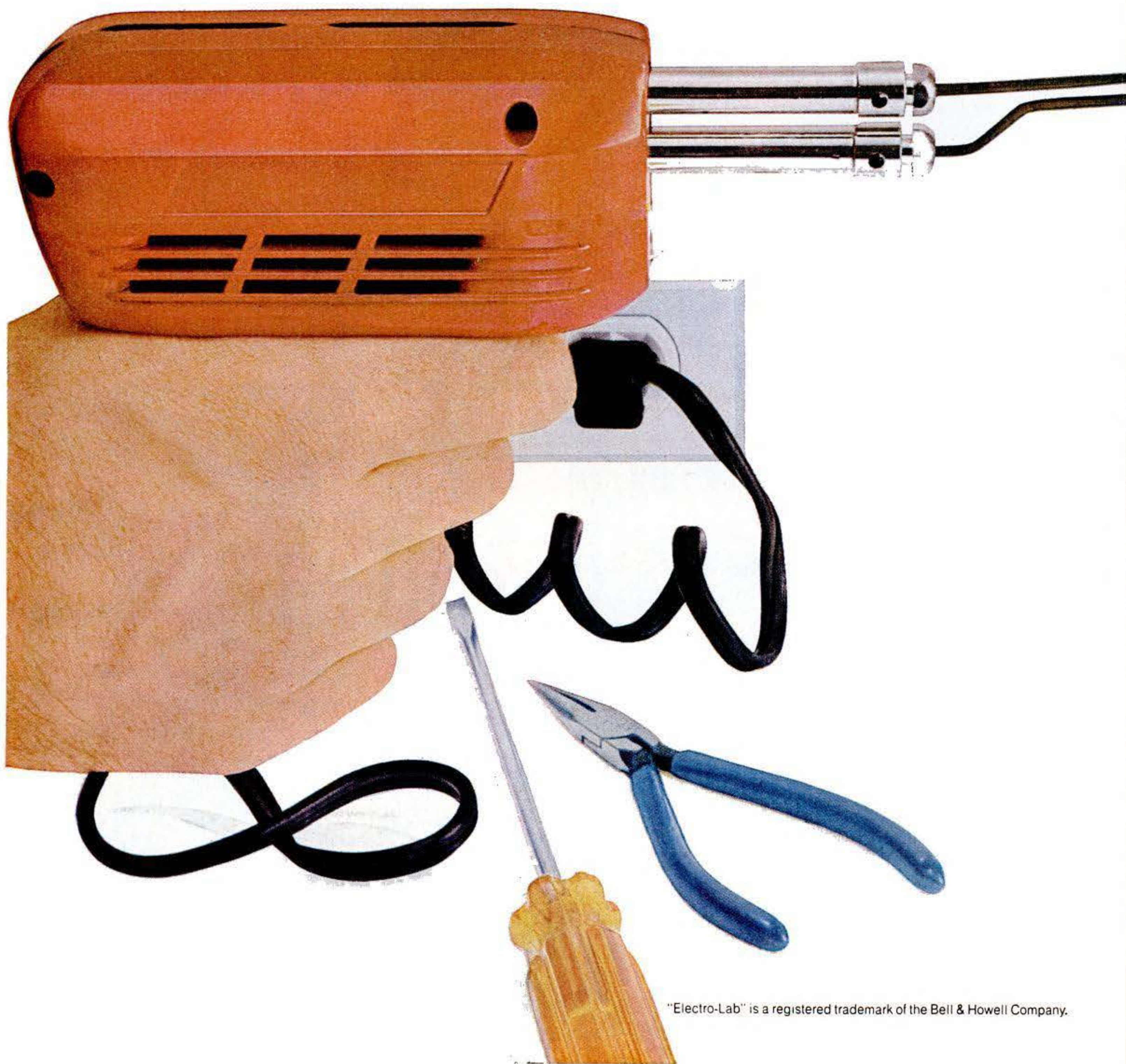
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What's more, by gaining knowledge of the new, more accurate *digital system* of electronics, you'll have the most up-to-date electronics skills under your belt... ready to qualify you for choice career opportunities in the digital industry or enable you to earn extra income part-time working on digital equipment.

Fix stereo systems... FM-AM radios... phonographs... tape recorders

With your new skills, you can build and service stereo-hi-fi systems—including FM-AM radios... phonographs... open reel tape recorders and cassette or cartridge player/recorders. You could even build yourself a complete "home entertainment communications center"—complete with the new gadgetry of cartridge television when it comes out. The skills you build by following this unique program are more than enough to service almost *any* type of home entertainment electronics device.

A complete at-home learning program in home entertainment electronics

Your color TV project is probably the best way for you to learn the most advanced "state of the art" concepts of sophisticated electronics circuitry. It's part of a complete at-home learning program prepared by skilled instructors at Bell & Howell Schools. Mail the postage-free card today so that our representative can bring you all the facts at no obligation.

It doesn't matter if you've never had any training in electronics before. Nobody's going to start throwing "diodes" and "capacitors" at you right off. You start with the basics. You take it one step at a time. You walk before you run. And you'll be amazed at how quickly you start to feel comfortable with things that seemed complicated at the beginning.

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Master the most up-to-date solid-state and digital technology

As color TV moves closer toward *total* solid-state, and as the more accurate and reliable *digital systems* appear in home entertainment electronics gear, you'll be

thoroughly familiar with the most advanced troubleshooting techniques for the servicing and repair of this new equipment.

Digital electronics is changing our lives

Computers. That's where this new digital language of electronics first began. If it weren't for *digital electronics*, the new pocket calculators and digital clocks would not have been born and on the market today. Soon, everything from speedometers to stereos to kitchen stoves will likely have digital measurement—direct numerical readouts in place of conventional dials and needles. Plainly, the demand for *digital systems*—and technicians who can design, build, service and repair them—is growing rapidly.

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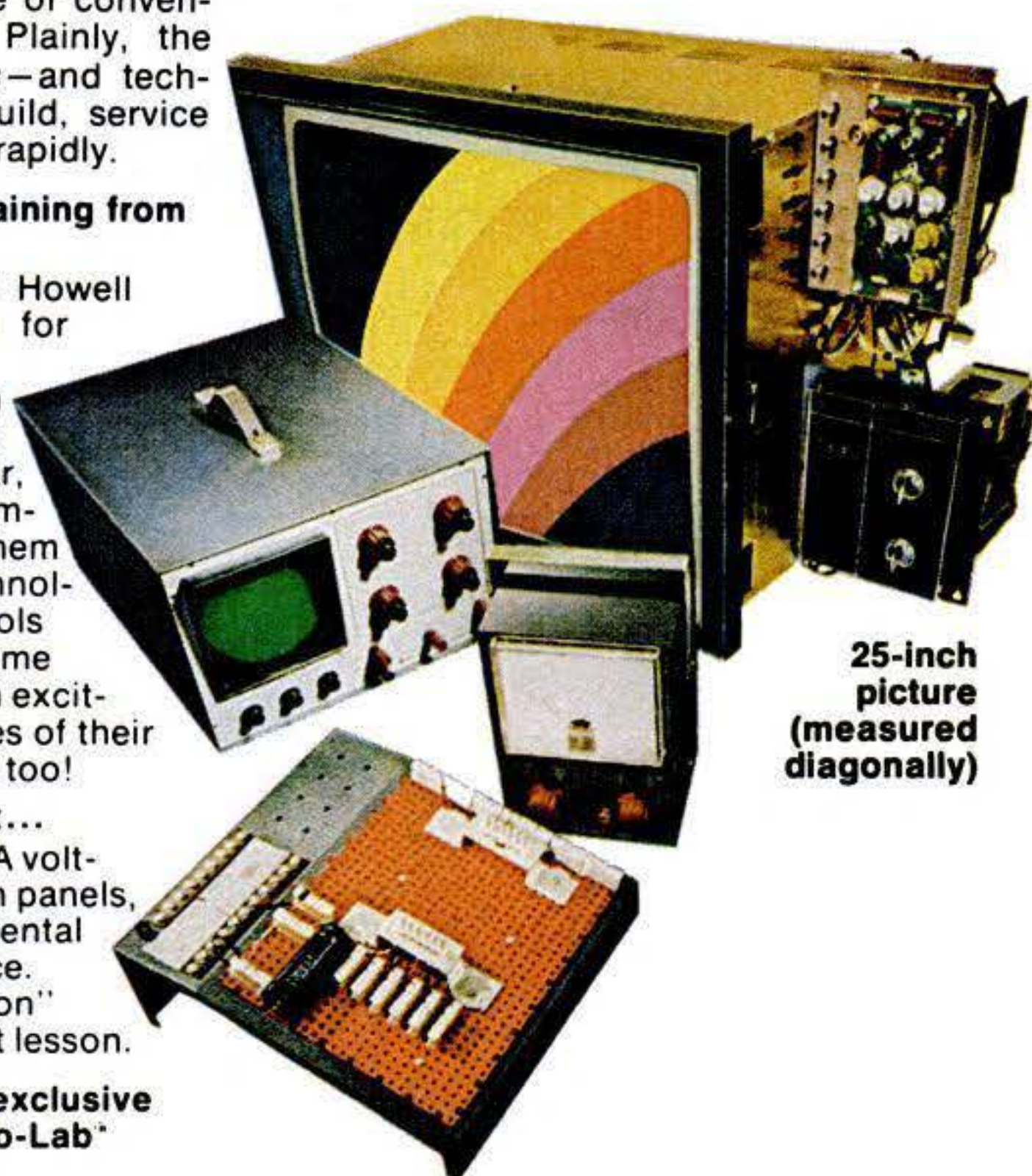
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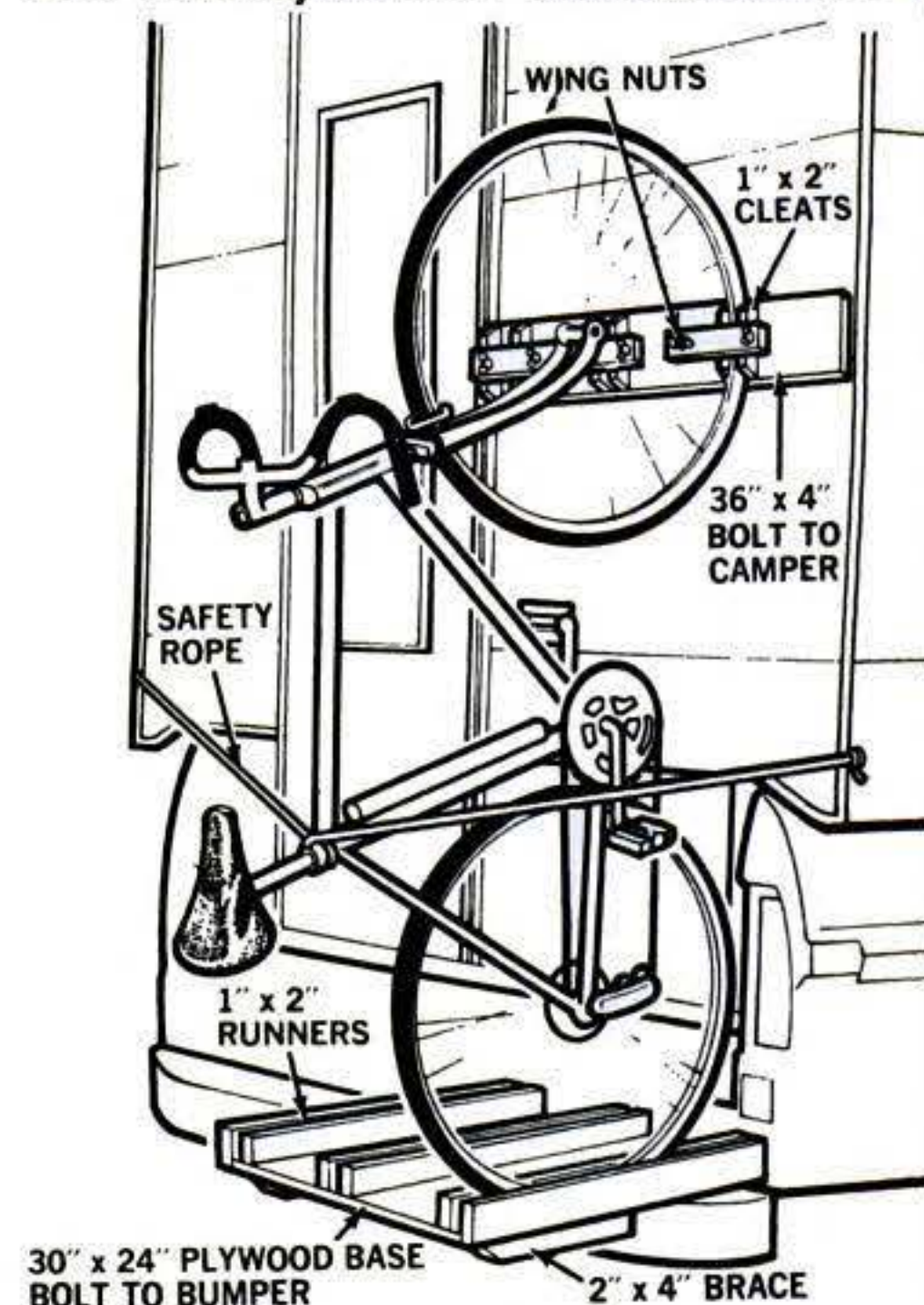
Unlike most of the recreational shows I've visited lately, the big Marine Trades Exhibit at Chicago's McCormick Place was a jolly gathering. That's because sales of boats and outboard motors are booming.

We spotted some new trailerable boats in the 21- to 24-foot class with eight-foot beams, which are winning new friends [PS, Nov.]. There was also an innovative new jet from New Zealand. Boston Whaler unveiled a new family-style boat—a departure from its "man-type" models.

Two things we thought silly were the proliferation of humped bows that slant up and are slippery to walk on, and fake fur interiors in runabouts.

There was some feeling at the show that some new products were being held back for introduction at the New York show next month, including an outboard over 150 hp.

The do-it-yourself outdoorsman



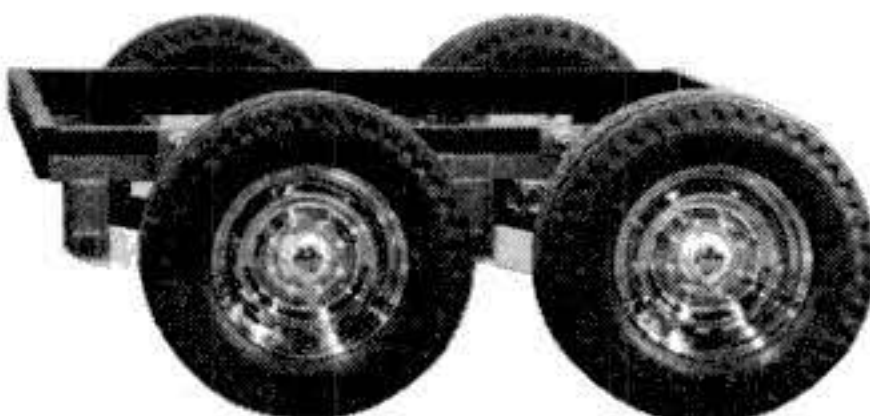
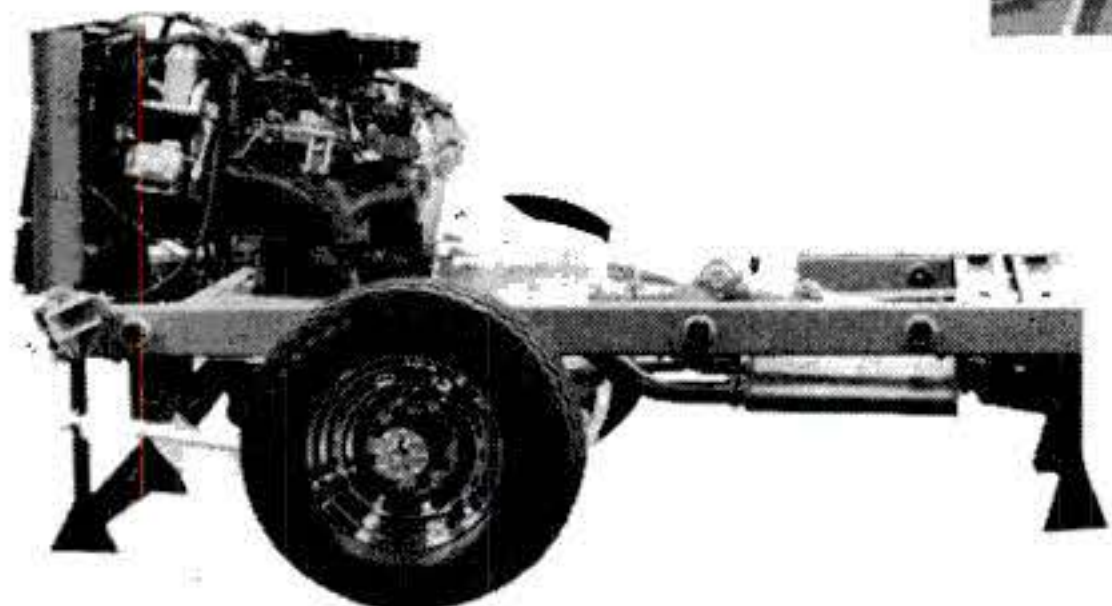
How can you take three bikes along when you drive a pickup camper? Bud White of Woodland Hills, Calif., designed this rack made of scrap plywood, one-by-twos, and one-by-fours. You can build it to accommodate from one to three bikes. A piece of rope from each side of the camper goes through each bike to prevent sway when cornering and acts as a safety tether. The two-wheelers go on or off fast.

Roundup

on and off the road



By HERBERT SHULDINER



New front-wheel-drive chassis for motor homes

Holiday Rambler recently announced a new motor home that will go on sale in the second half of next year. Holiday's rig will be unique because it will use a totally new front-wheel-drive chassis made by AM General, a wholly owned subsidiary of AMC.

The new chassis, consisting of front and rear units, can be used to build motor homes ranging from 20 to 30 feet long. The chassis will come with either a 360- or 401-cu.-in. V8 engine and a four-speed automatic transmission. The rear unit is available with single or tandem 4500-pound axles, each with its own independent air-spring suspension. No prototype motor homes have yet been built on this chassis, but one other major RV manufacturer is already dickering to buy it.

Rotary motorcycles coming

Both Suzuki and Yamaha are working feverishly to introduce Wankel-powered bikes here some time next year. But the two Japanese firms are encountering some difficulties in eliminating minor bugs. The powerplants are expected to be in the 650cc range.

LPG—new crisis for RV owners

Even if you've got the gasoline to take a trip in your RV, your worries might not be over—especially if you're planning to travel this winter. That's because propane gas is in short supply. Prices of this fuel have already doubled over last year and may double again during the coming year.

But there's a good chance that when the camping season starts its peak period after Memorial Day, supplies may be adequate—albeit more expensive.

How do you cope with this situation? Be sure that you're adequately stocked before traveling into a strange area. Don't wait until you're completely empty before refilling your bottles. Make sure you run your LPG-electric refrigerator on current when a hookup is available or off 12-volt batteries when you can recharge them conveniently.

Incidentally, disposable propane cylinders used in lanterns, stoves, and catalytic heaters will also be affected by this shortage and will be more expensive.

Suburban Propane, one of the largest propane suppliers in the country, offers free its "Guide to Gas Service Anywhere," which could help you find refill stations more easily. You can get a copy from Dept. TGF73, Box 206, Whippany, N.J. 07981.

Are lantern mantles dangerous?

Kyle Griggs, a scientist at the Lawrence Livermore Laboratory in California, says experiments he's run lately indicate that you can endanger your health when you burn a new lantern mantle in a small, closed space like a camper. The reason? Hazardous amounts of beryllium and radioactive thorium are released during the first 15 minutes of burning. Griggs advises that you exercise greater care when burning new mantles in camping lanterns.

We checked with some major mantle makers and sellers, who claim they haven't had time to check Griggs' findings. We'll follow up with their answer in an early issue.

National Parks signs go metric

Did you know that the south rim of the Grand Canyon is 2099 meters high? The next time you visit the spot, you'll find a National Parks sign telling you that—along with the height in feet (7000). Besides helping U.S. citizens get used to thinking in metric terms, the dual-system signs should be helpful to foreign visitors.

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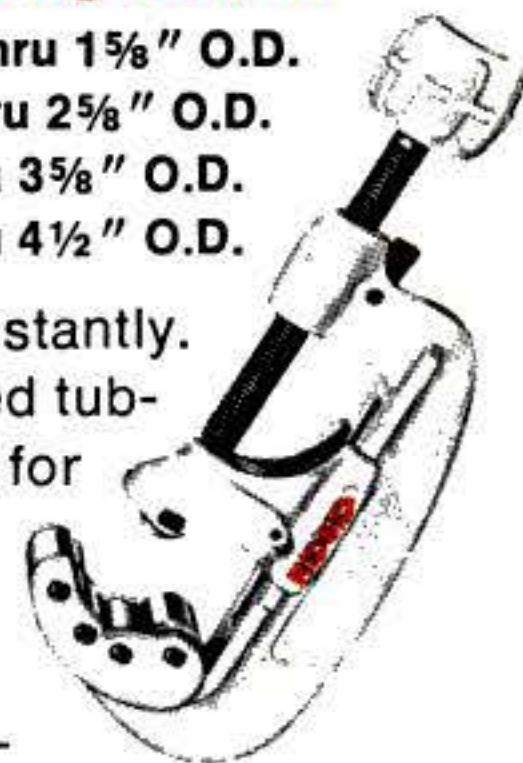
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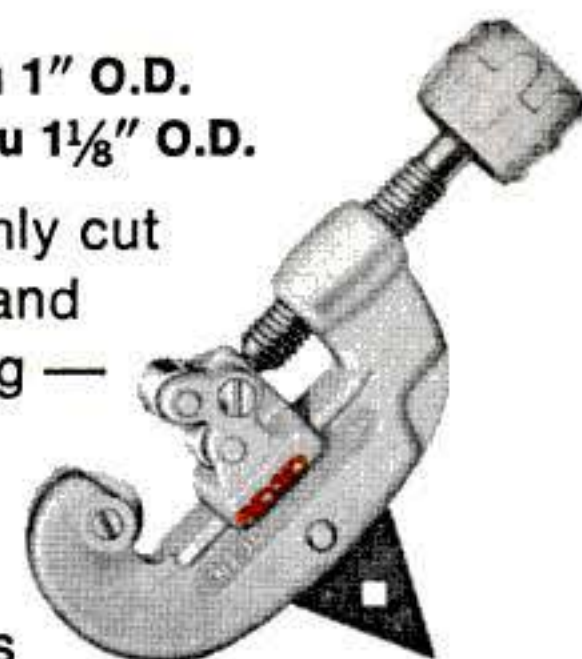
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Detroit Report

Behind the scenes in the auto industry

By JIM DUNNE / PS Detroit Editor

Overdrive again? Gas economy may bring it around

The auto companies are taking a renewed interest in overdrive systems in the face of criticism of big-car fuel economy. GM and Borg-Warner have overdrive units for automatic transmissions. The GM system is simply a fourth gear on a Turbo-Hydramatic transmission. It provides about a 20-percent increase in highway-speed economy. The B-W system is actually a two-speed rear axle that fits about any big car built today, manual or automatic. The high cost of these units is being offset by higher fuel costs and the lower economy of emission-controlled engines. Pontiac is investigating the GM and B-W systems for possible future use. But it looks like gas prices will have to get even higher before the units will make sense from a price standpoint.

Headlights in different shapes?

If the federal government's proposed standards on headlights are adopted, the headlight business will go through a revolution. The proposal includes rectangular headlamps for two- and four-headlamp systems, and a new three-beam system with a setting between high and low.

Lighting manufacturers like General Electric want to improve the maximum candlepower from today's 75,000 to 150,000, primarily upgrading the high beams. GE does not like the rectangular shapes. They mean more proliferation, more confusion, and less availability of odd sizes.

Now there are three legal headlamps on the U.S. market: The one used in single-headlamp systems, and the two in the dual-headlamp system. Government proposals would boost this to 11, complicating production as well as supply.

Sealed beams: future secure

GE, which makes a minor share of the 60 million lamps produced each year—mainly because GM does its own sourcing through Delco—believes that the sealed-beam headlight will continue to be the only legal one sold in the U.S., even after the standards are changed next year.

GE engineers say the round sealed beam in an improved four-headlight system is the best available for all-around lighting and simplicity of operation. High beams have a possible use of only 15 percent of nighttime driving, but are actually used only five percent of the time. Criticism of nonsealed-beam headlights centers around the fact that they breathe as they heat up and cool off, with the result that reflectors become tarnished from the moisture pulled inside the lens.

Cadillac clams up

After two years of talking about the progress of its small car, Cadillac has suddenly pulled a curtain of secrecy over the entire project. That probably means the car is on the verge of getting the green light from GM management. Latest word is that the Mercedes-type model will have front drive, be offered as a four-door sedan, sell at a premium over the regular Cadillac models, and be introduced as a 1976 model.

The Wankel engine is still very much in the running as the powerplant, though the Caddie V8 is not out of the picture completely. Best guess is that the division will offer both a V8 and GMRE, but the chances of going completely rotary are good. Old plan to import Opel body from Germany and put Cadillac name on it for U.S. sale was discarded.

Lincoln has one, too

While Cadillac is making all the motions about a smaller luxury car, Lincoln has been getting a similar model ready for 1976 production. The new model will have conventional driveline, V8 engine, and the same kind of opulent interior finish found in the Mark IV. This model is in addition to the bigger, Fleetwood-type Lincoln being planned for introduction at about the same time.

What it amounts to is that Lincoln will be able to match Cadillac model for model in all markets except one—the nine-passenger limousine. The future lineup will include the present Continental two- and four-door sedans, the Mark IV, the small sedan, and the bigger four-door.

It may look like the wrong kind of marketing move in the face of dwindling big-car sales, but auto officials point out that the luxury cars have been immune so far from the general trend to cheaper models.

Sales have been increasing for Cadillac, Lincoln, and Mercedes while lower-price full-size cars are down.

Motor-home fuel economy

In a recent test of a 10,500-pound, 26-foot motor home conducted by one of the bigger companies, it was found that fuel economy ranged from 6.8 mpg at 75 mph to 10.2 mpg at 50 mph. This is steady driving of the type usually encountered by motor-home drivers. In contrast, the EPA says that the Oldsmobile Toronado only gets 6.8 miles per gallon in its emission tests.

Two differences explain the apparent advantage: The motor home doesn't meet emission standards, so the engine can run at its best efficiency; and the EPA mileage test is far tougher than running at a steady highway speed. Look for a lot more explaining from car producers later as the public begins to base its buying on EPA results.

Smaller is not cheaper

The new Mustang II, smaller, lighter, and lower powered than its predecessor, is selling for more. In fact it costs more to buy the lowest priced Mustang than it does for the bigger and higher powered Camaro. The story at the top of the model line-up is the same: Camaro's V8 costs less than the Mustang V6.

Ford evidently thinks that it can get away with the higher price tag because of the general switch to smaller cars. But Chevy is delighted with the price development, and expects to sell all the Camaros it can build in the coming year. There is only one hitch. Chevy is severely limited in the number of Camaros it can produce. Ford, perhaps anticipating this, went out on a limb with the Mustang price. It looks like they want to sell all they can before competition gets similar products in the new Mustang market.

Scramble for the GMRE is on

Pontiac, Olds, and Cadillac divisions are scrambling to get on the rotary-engine bandwagon. But they have to wait in line. Chevrolet is getting all the first-year production, now estimated at 165,000-200,000, for its Vega-type sportster model. Later, as more factories are put into production, engines will be available for the other divisions.

But who gets them first is a matter of concern. Cadillac seems to have the inside track for about 50,000 engines for its Mercedes-type car. After that it is a dogfight.

Chevy wants all the engines it can build. But Olds has a lot of influence, and may convince GM management to divert some engines away from Chevy for its use. Pontiac, behind Olds in sales and in profit per sale, has less clout, must wait in line for what's left over. **PS**



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25 mg. "tar," 1.6 mg. nicotine av. per cigarette, FTC Report FEB. '73.

For Home Movie Makers, Now It's "Talkies"



Loading is easy with a drop-in cartridge. Sound? It's on a magnetic stripe

By EVERETT H. ORTNER
Group Editor, Consumer Information

"Okay," I said. "Everybody keep talking while I shoot."

Immediately there was silence at the party. "What should we talk about?" somebody asked.

That's one problem with the Ektasound home-movie system: getting people to talk naturally.

Kodak's new Ektasound movie system [PS, Oct. '73] is the first to offer the ease of drop-in cartridge loading along with a sound head in the camera itself. No separate recorders are needed. It's like shooting silent movies, except for: 1) plugging in a microphone, which is simple, and 2) holding the mike in good listening position while you're shooting, which takes some doing.

For all its bulk and almost four-pound weight, the camera is surprisingly easy to handle. I used the model 140, which has a 9-21mm zoom lens and a slightly fancier viewfinder (*not* through the lens) than the single-focal-length (9mm) model 130. By now, super 8 cameras and film have reached a stage where the amateur, with a little practice, can produce excellent home movies. The new Ektasound cameras reflect that high level of development. The movie part of the movies is great. Particularly, if you haven't, you'll want to try Ektachrome 160 film, which produces superb effects at almost any light level.

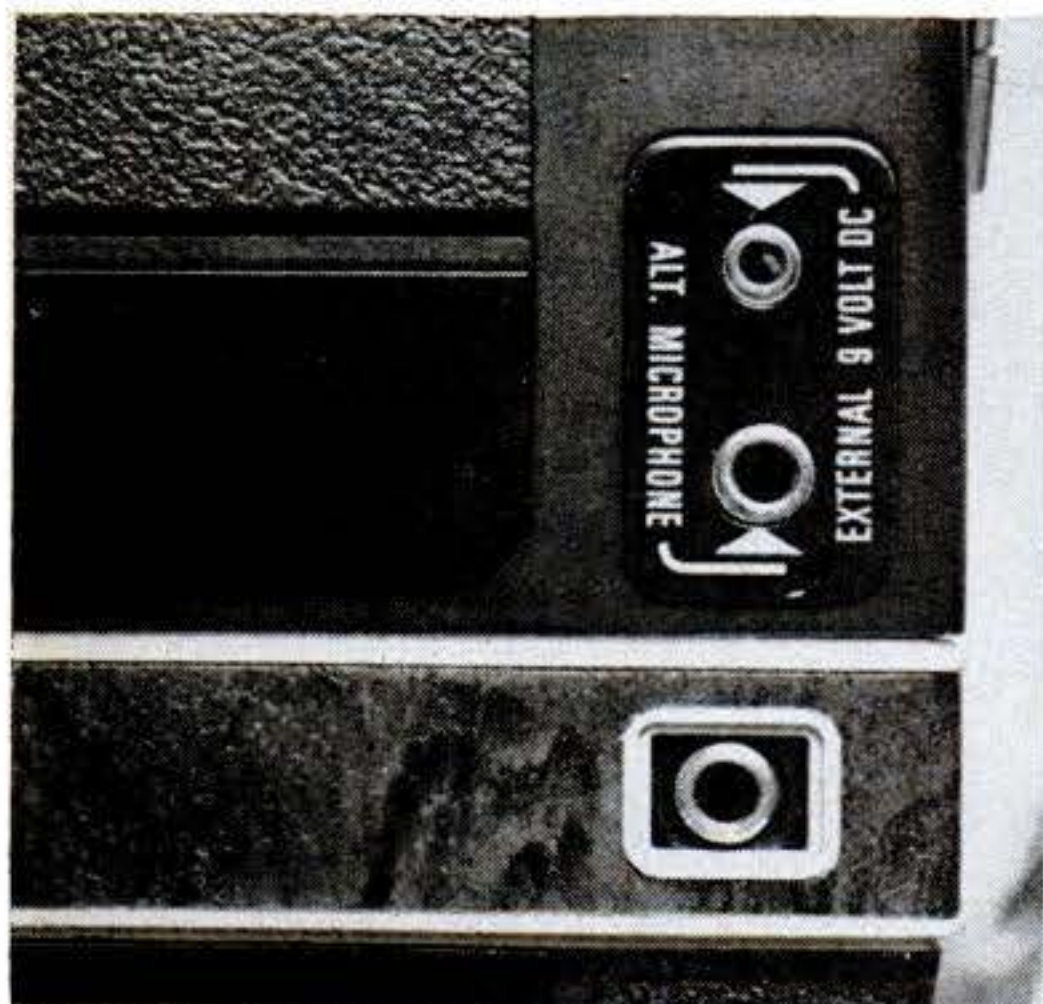
How's the sound? That's something else. Kodak advises that you place the microphone "near" your subject, and at least three feet from the camera (to keep out camera noise). That picture of me holding the microphone with my left hand is optimistic, to say the least. For adequate sound, you must place the microphone on a stand (supplied) very close to your subject—or else have a helper to hold the microphone near your subject. You've got 12 feet of microphone cord for maneuvering.

Now for the problems: The micro-
Continued
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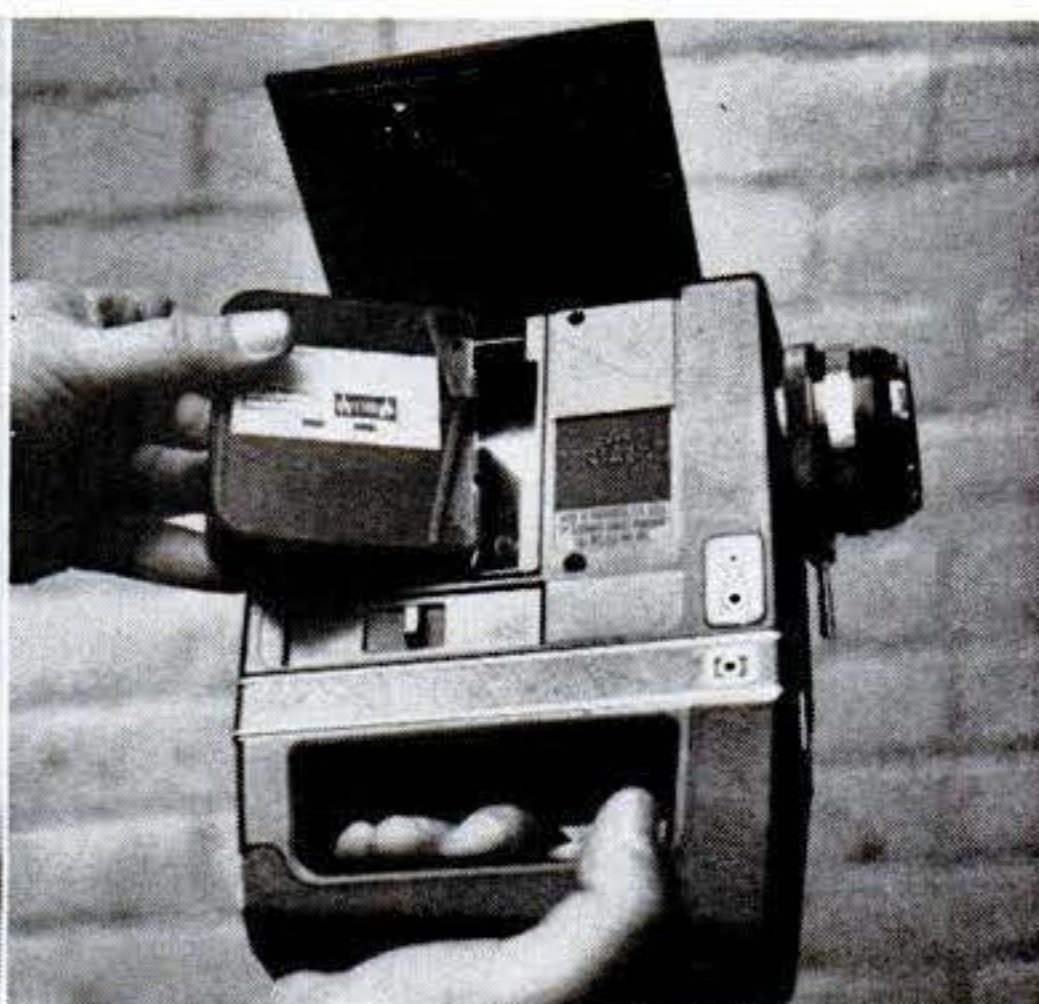


Sight and sound come together in the new Ektasound sound-movie camera. Microphone simply plugs in. Model 140 here is \$285. Model 130 (without zoom lens) is \$200.

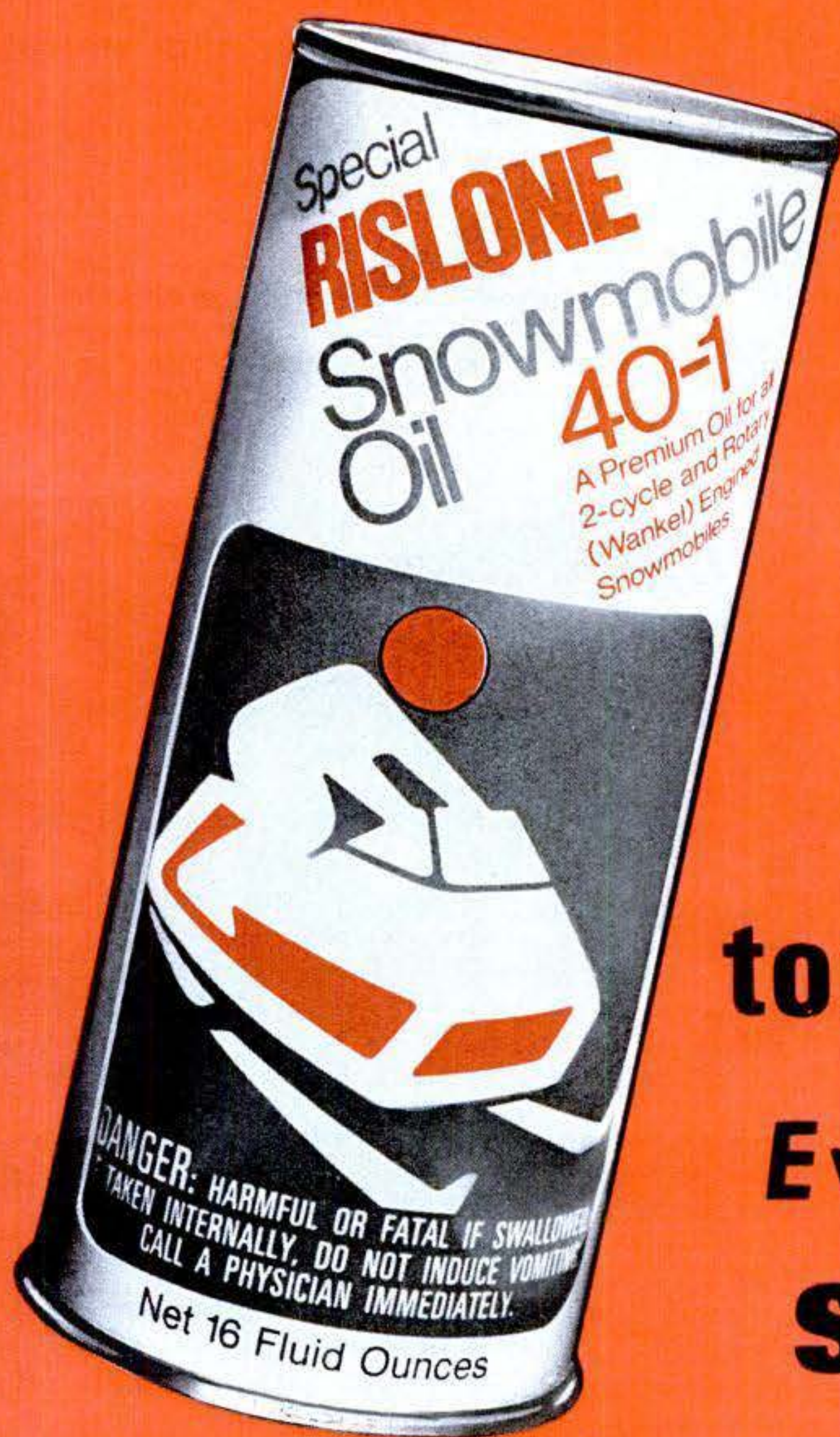
You set lens focus by guesstimating distance. Controls on side set the filters (for daylight or interior) and check battery.



Two mike jacks (bottom and center) are for standard use or high-ambient-noise use. Top jack is for battery pack.



Loading, from the side, takes just a bit more care than with silent cartridge, in order to slip cutout over sound head.



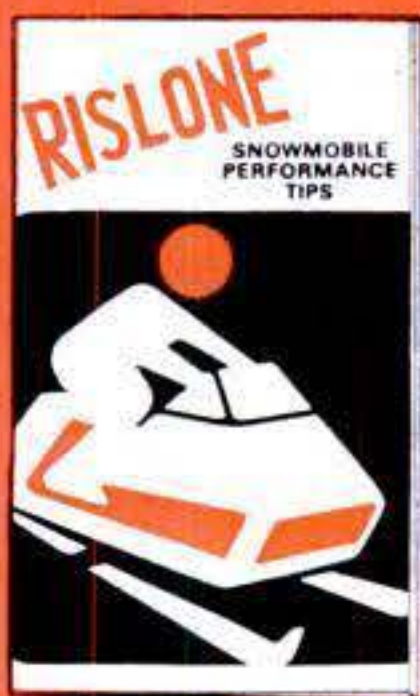
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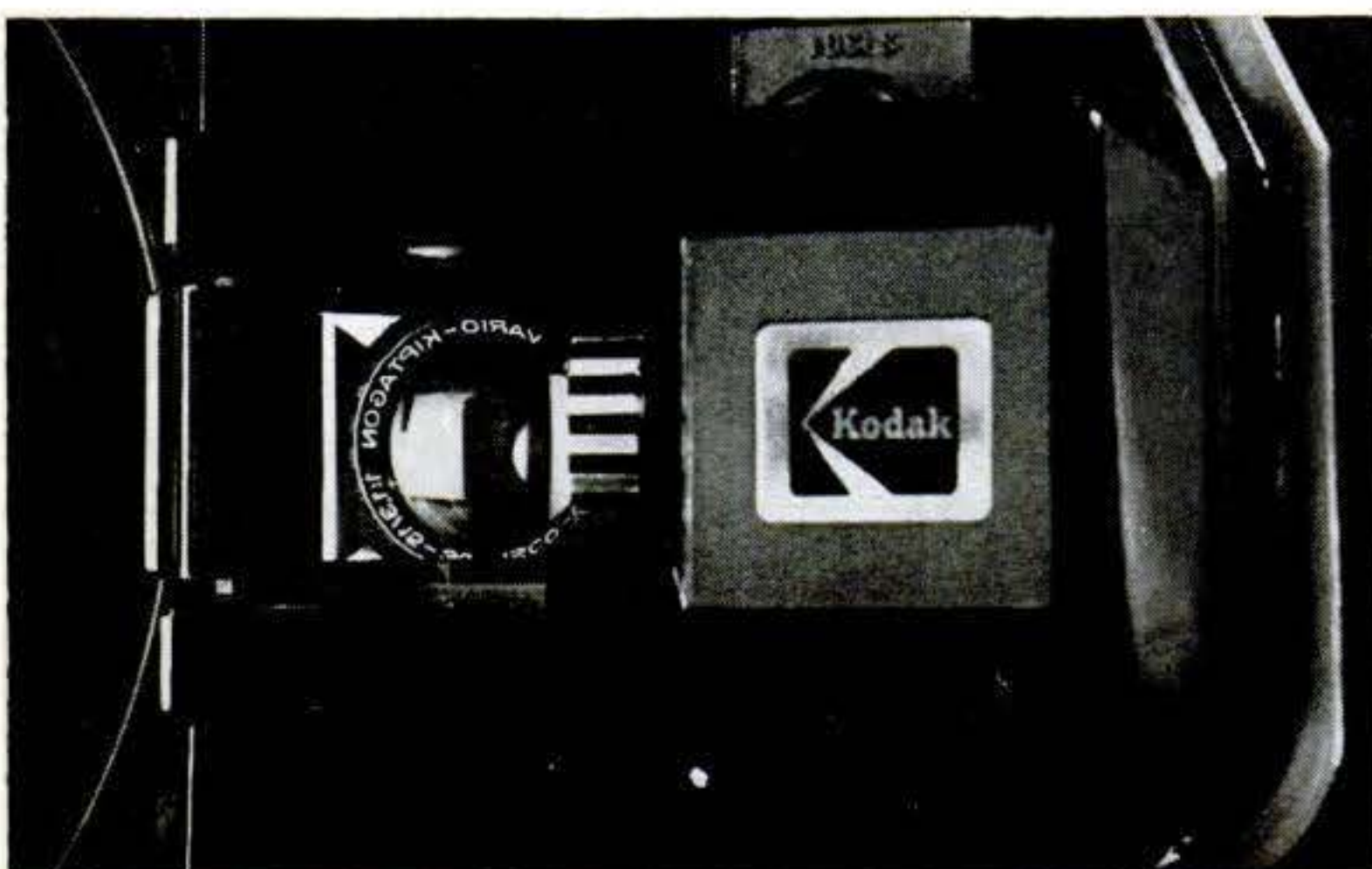
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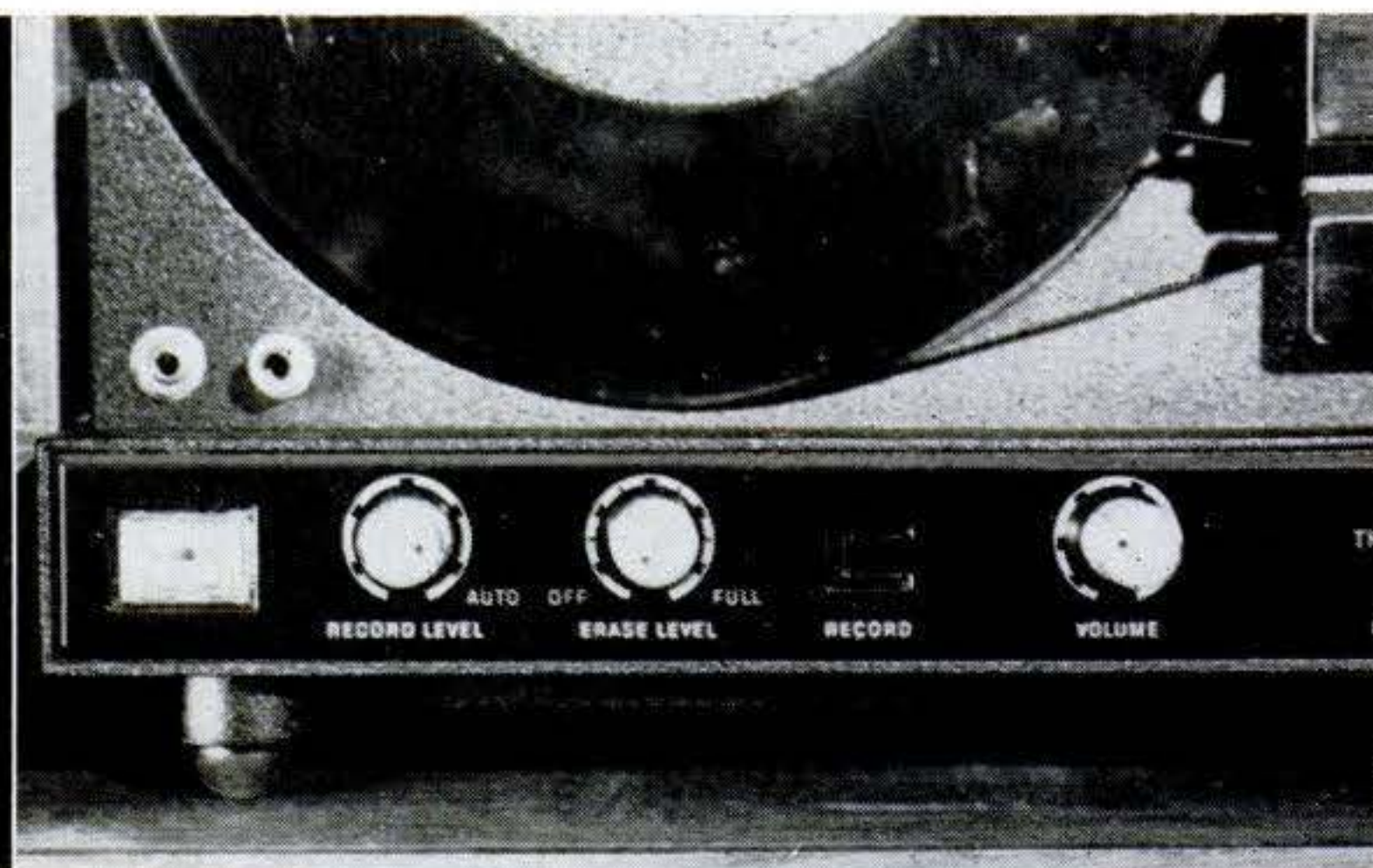


The projector gives you a second crack at the sound, to add music or narration

Wood-cased Ektasound projector looks great on bookshelf. Gray plastic cover (not shown) normally covers innards. Threading is simple: Slip film into channel, attach it to take-up reel.



Lens points sideways, but pivoting mirror flips to project scene forward (as above) or through rear of projector. Lens is 22mm f/1.5. A zoom 15-30mm lens costs \$30 extra.



Sound controls offer range of possibilities: erase, sound, sound-on-sound. Volume is set automatically by automatic gain control (AGC) or manually by using VU meter (left).

phone is omnidirectional—it picks up sound not only from your subject but from all other sources as well: a noisy passing car, a neighbor's lawn mower, the hi-fi.

To improve your chances of getting good sound, the camera offers an alternate microphone jack that attenuates the sound (by 10dB). This is recommended when subjects are speaking very close to the microphone or when the camera's machinery may be too easily picked up, as in small rooms with sound-reflecting walls. I found the alternate jack position helpful whenever there was much background noise.

Another mike? An alternative is to have an additional microphone—unidirectional—for times when unwanted noise is a problem.

The sound, even when all goes well, is not of high quality. Frequency response of the system, Kodak says, is 200 to 5000 Hz—which limits its ability to discriminate among low-frequency sounds, "mushing" them together. The limitation, however, is not of the cartridge, but of the camera's own sound system.

The cartridge is the heart of the system. Taller by 0.6 inch than the silent cartridge, it has an opening in its bottom for the sound head of the camera. A magnetic stripe on

the film carries the sound signal. It is unaffected by processing.

You can, incidentally, shoot silent super 8 cartridges in the camera (a notch in the cartridge tells the camera whether to turn its sound recorder on, and modifies the speed: 18 frames per second for sound, about 20 for silent). And you can add sound, later, to silent film by having it magnetically striped (cost range: two to six cents a foot).

Other systems. There are, of course, other movie sound systems—although none with the dual-purpose cartridge. Bell & Howell's uses a separate synchronized tape-cassette recorder for sound, and film and tape are played back simultaneously. The Optasound system records sound the same way, but transfers it to a magnetic stripe placed on the film after processing. While playback is the same as with Ektasound, the recording system offers the possibility of higher quality, and your own present super 8 camera may be modifiable to synchronize with an Optasound tape recorder.

Whichever sound way you go—Ektasound, Optasound, or separate striping of your silent super 8 movies—as long as you have magnetically striped film, you can play it in an Ektasound projector.

Super 8 sound projectors for magnetically striped film are not new, but the Ektasound units offer some fresh design ideas:

- Shape, styling, and material (wood) that suits it to a bookshelf.
- A two-way mirror that flips to project from either side of the unit: from your bookshelf, or from the rear with you at the front controls.

Again, there are two models: model 235, a simple playback machine; and model 245, with both record and sound-on-sound capabilities.

If you intend never to add music or narration to your sound movies, or erase unwanted sound—or add sound to your silent movies—model 235 (\$219.50) will do fine. If you're more ambitious, you'll need model 245 (\$279.50). It opens the door to semiprofessional sound: narration, musical backgrounds, sound effects—everything, in short, except "lip sync," which, of course, only the camera can do. It gives you a second shot, too, at a poor sound track—you can replace it with narration or music.

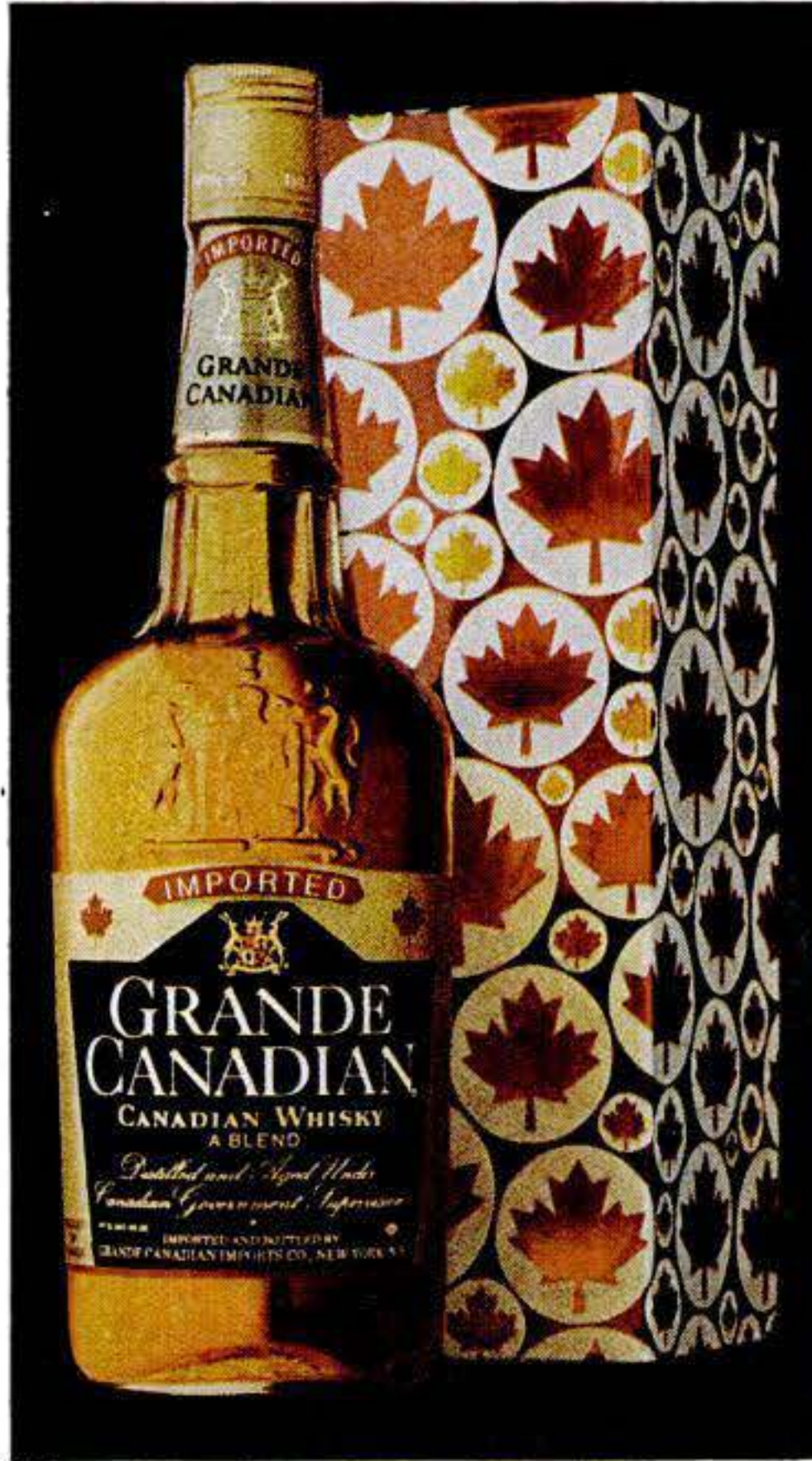
Power output by the amplifier is three watts—fine for home purposes, and the speaker is built in.

All in all, the system is here. Now it's up to you Cecil B. DeMilles to show what you can do. **P3**

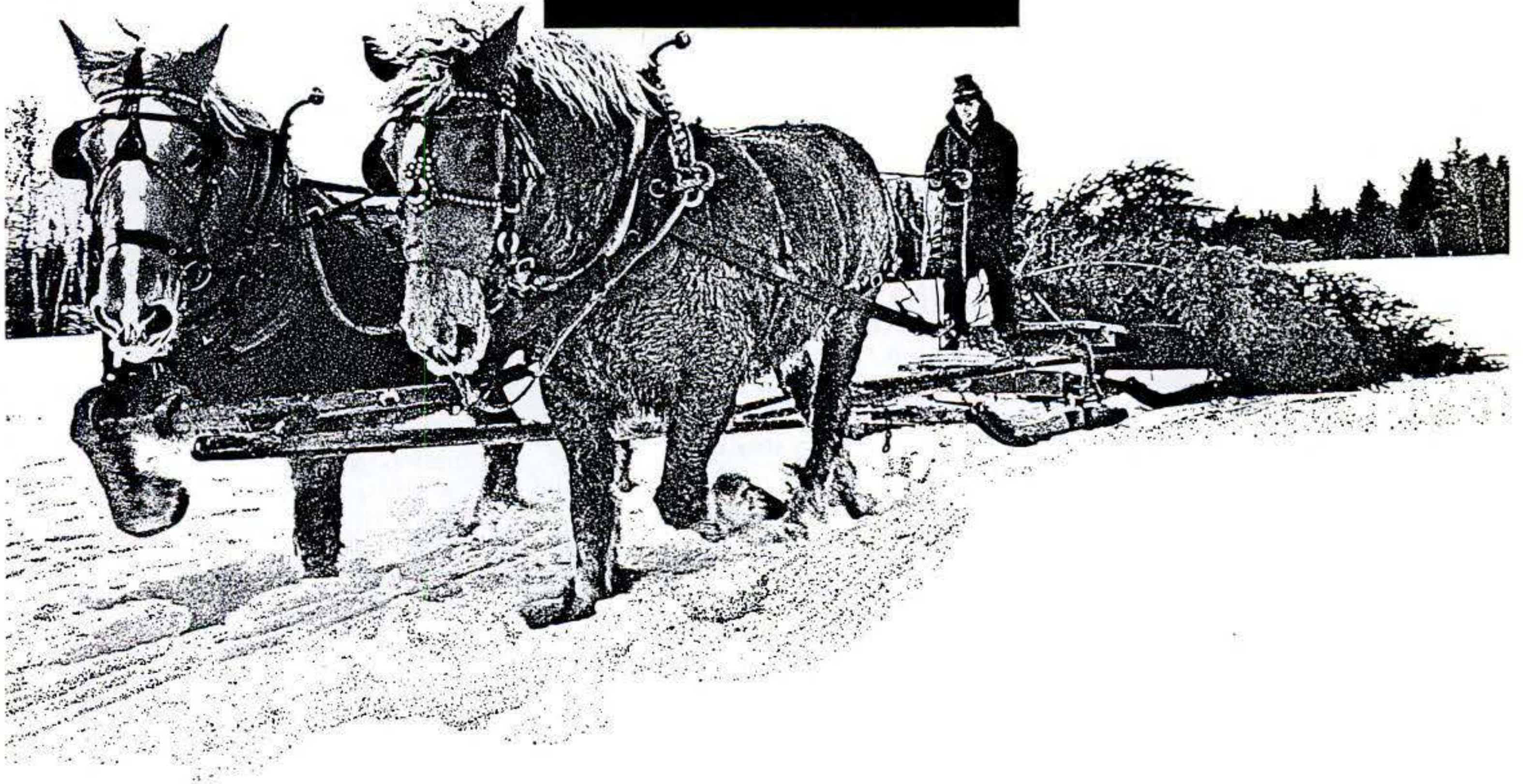
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rich Canadian grains,
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comes Grande Canadian.





The View Down the Road

... news and comments on cars and driving

By JAN P. NORBYE / PS Automotive Editor

DATELINE: FRANKFURT AM MAIN, GERMANY

Why no Wankel car from Stuttgart at the international show?

It was Germany's first international auto show in four years, and I found a surprising contrast. In 1969 Mercedes-Benz showed the C-111 prototype with a three-rotor Wankel engine, but this year Mercedes is still no closer to building a Wankel-powered production car. Citroën of Paris had not yet announced its M-35 single-rotor pilot program at the time of the last Frankfurt show, but chose the 1973 event to display its production model—the GS Birotor (I'll give you a full report next month). And GM, which did not sign a Wankel agreement until late in 1970, now had an experimental Corvette with a twin-rotor Wankel as the center attraction.

To find out the real reasons for the Mercedes holdback on the Wankel, I went to Stuttgart to interview Peter von Manteuffel, assistant to the technical director, and a man with years of Wankel experience from NSU. He showed me experimental engines with 2, 3, and 4 rotors, and demonstrated the newest developments, such as a new lubrication system for the apex seals. Instead of the sleeve with the oily surface in the intake port, oil is now fed directly to the seal by small canals on either side of the intake port. We looked at samples of apex seals made of different materials, including many with a silicon nitride or silicon carbide basis.

Peter von Manteuffel explained that durability in the Wankel is still not up to par with Mercedes piston engines. We saw rotors that had overheated and rotors whose internal gears had been chewed up. Equally important, fuel consumption is higher than in piston engines of similar power. Until the Wankel comes up to Mercedes standards for life and fuel mileage, it will remain in the experimental stage. According to Hans Scherenberg, the technical director, it is an open question whether the Wankel will ever be offered in a Mercedes car.



More emphasis on the diesel

This year about 36 percent of all new Mercedes cars will be diesel-powered. A new 240 D shown at Frankfurt will probably replace the 220 D on the U.S. market. Not on display was a future 300 D with three-liter (183 cubic-inch) five-cylinder diesel engine. Five cylinders? Sure. Five-cylinder truck diesels have been around since the 1930s

in Europe, and Mercedes now builds a V10, too.

Opel and Peugeot displayed a range of diesel-powered cars, including station wagons. Peugeot now installs diesels in about 16 percent of all new cars; Opel in less than 10 percent, perhaps because the diesel is only a year old, perhaps because it is not offered on the lowest-priced Opels (Kadett and 1900) but only on the more expensive Rekord II series.

Volvo: growing multinational

After the official opening of the Frankfurt show I got the news of Volvo's plans to start car assembly in the U.S. with a planned output of 100,000 units a year by 1980. This fits perfectly into the picture of Volvo's expansion outside Sweden. Last year Volvo bought one-third interest in the passenger-car side of DAF in Eindhoven, the Netherlands. DAF and Volvo products don't compete but form complementary lines and offer interesting possibilities for new-product planning.

Volvo has a new engine in the works — a single-overhead-camshaft four-cylinder unit designed in collaboration with Renault and Peu-

geot. It will be built in a new plant in France, and supply all three companies.

But Volvo's most ambitious expansion plans lie in the truck and bus fields. Volvo is talking with Berliet (a truck maker in Lyon, France, now controlled by Citroën) about a merger. A new range of trucks is being designed in a joint program with Saviem (owned by Renault), DAF (one-third controlled by International Harvester), and Deutz in Germany. Volvo built 18,000 trucks last year; plans to make 40,000 a year by 1980.

Ford and GM gaining in Europe

In new-car sales, GM's Opel is Number One in Germany, ahead of Volkswagen. Ford is behind, but has recently upped production at the modern Saarlouis plant that assembles the popular Escort. Ford's prospects are excellent, with a new Capri due next year, and plans to sell 10,000 U.S.-built Mustangs in the Common Market. Ford recently took first place in truck production in Europe, and offers a wide range of diesels. In fact, Ford of Europe is the second-largest maker of diesel engines in the world (behind Perkins). The light-truck Ford diesel has the Ricardo Comet V cylinder head (also used by Peugeot) and could certainly be developed for passenger-car use.

Porsche and the 20-year car

In addition to building sports and racing cars in Stuttgart, Porsche undertakes automotive engineering projects of all kinds under contract with other firms. VW has been an important client over the years.

While many Americans have been talking about the "disposable" car, the technical director of Porsche, Ernst Fuhrmann, is looking toward the everlasting car. Porsche displayed a proposed design at the Frankfurt show. It's a two-door four-seater family car and features contemporary styling.

Its news lies in the specifications — such as the most durable materials to assure 20 years' life or 200,000 miles. The engine is a slow-running understressed unit. Body panels are mostly aluminum, and electrical contacts are silverplated. Porsche says it will cost 30 percent more than a normal 10-year car, and will still have fair resale value after 20 years.

It is an interesting project, but highly controversial, for it fails to take into account the rate of technological progress. The rate is still accelerating, and Porsche might find in five years that it could build a far better car at lower cost. In the meantime, a lot of customers would have bought expensive cars that have suddenly been made obsolete — though still good for another 15-20 years' use.

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- Quadra-Trac™, Jeep Corporation's acclaimed automatic 4-wheel drive
- Automatic transmission • Variable ratio power steering
- Power front disc brakes • Big 360 V-8 engine

4-wheel driving becomes a new experience in the '74 Jeep Wagoneer. Quadra-Trac . . . automatic 4-wheel drive, praised universally by the experts, offers the ultimate in traction plus greater stability and control regardless of road surface.

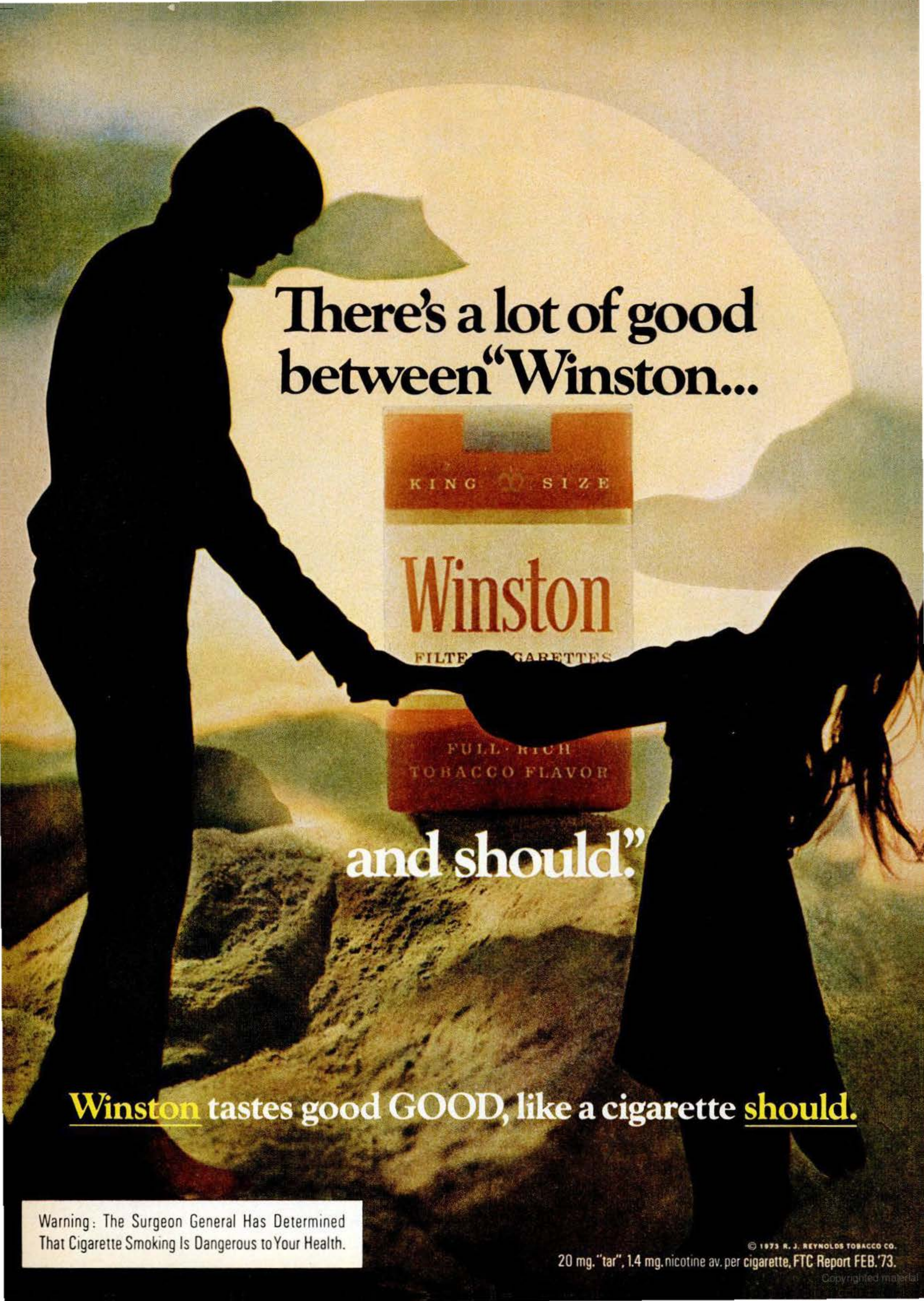
New options include a 401 4b V-8 engine and a special trailer towing package.

Comfort options include: air conditioning, AM/FM radio, plus tilt steering column. This 4-wheeler offers exceptional luxury plus the rugged dependability that Jeep Wagoneer has come to stand for.

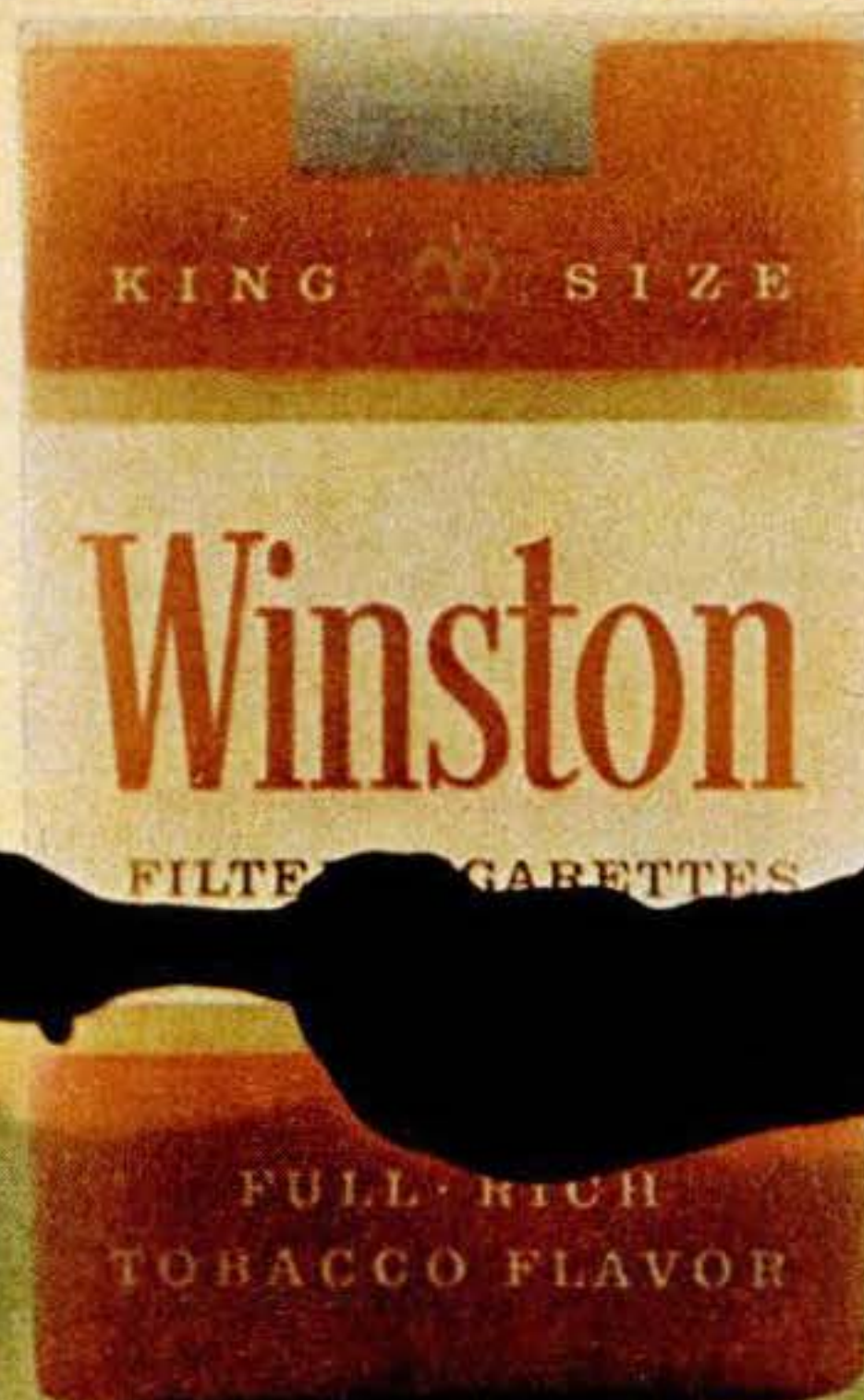
On road or trail, Jeep Wagoneer is the Ultimate in 4-wheel drive vehicles.

Jeep Wagoneer

From A Subsidiary of
American Motors Corporation



There's a lot of good
between "Winston..."



and should."

Winston tastes good GOOD, like a cigarette should.

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

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20 mg. "tar", 1.4 mg. nicotine av. per cigarette, FTC Report FEB. '73.

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Keeping You Posted from Behind the Scenes

Mention the subject of shaving and shavers in any group of men I've ever encountered and you'll trigger a lively discussion that will continue until every man in the group has at least described his preferred routine and instrument. If time permits, you'll also learn that each feels he has a unique problem—wiry beard, tender skin, etc. When we launched our project to report on the latest crop of electric shavers, we hoped we could bring you some definitive answers. When the score sheets from our testing panel were all completed, we found that simple answers were not going to come easily. You'll find out all the details in the story beginning on page 73.

Honda CVCC engine gets another boost

Now that Chrysler Corporation has signed an agreement with Honda giving Chrysler the non-exclusive worldwide right and license to make, use, and sell Honda's CVCC engine system, three of the world's largest automobile manufacturers have placed bets on the future of the stratified-charge engine. Ford, Chrysler, and Toyota have now signed up to make and sell the engine. GM and American Motors have limited-disclosure agreements with Honda, but have not paid the price for a license to make and sell it.

The history of the stratified-charge engine again illustrates how long—and how much development work—it takes for a good idea to reach the point of commercial acceptability. Smart engineers have been attracted to the concept for at least 30 years. We ran articles on working prototypes in the 1950s and had a cover feature on Ford's version in July, 1968. Our cover story on the Honda CVCC ran in the April, 1973 issue. According to reports we have heard, Honda engineers became convinced that stratified charge was the way to go some time in 1969. There is no magic in what they have done—they simply persisted in massaging the weaknesses and drawbacks that showed up in the early prototypes until they perfected an engine that the National Academy of Sciences Committee on Motor Vehicle Emissions called the "most promising" of those they have investigated.

What ever happened to MHD?

It should be apparent to informed persons that we have reached the point of diminishing returns in our efforts to meet our energy needs from familiar sources. Yet serious proposals for alternatives are, more often than not, shot down as so much science fiction when priorities for R&D money are decided. Such has been the fate of MHD generators. MHD is an acronym for magnetohydrodynamic. When we published an article on MHD generators in our June, 1969 issue, operating prototypes were already demonstrating their feasibility. They use streams of ionized gases moving at supersonic speed through a magnetic field to generate electric power directly from burning fuel. An efficiency of 60 to 70 percent has been predicted, compared to the 30- to 40-percent efficiency of conventional turbine-driven generators. Research and development in Japan and Europe—particularly in Russia—has moved steadily ahead. The Russians plan to have a 25-megawatt MHD

power plant feeding into the Moscow grid by 1976. Ironically, it now appears likely that an American company (Avco) will design and build the giant magnet for the Russian MHD powerplant.

More about earthquake prediction

New results, expanding the horizons for earthquake prediction, have just been published. We got the word after our story on page 78 went to the printer. When author Gilmore was in Boulder, Colo., in August doing research for our story, he met a young scientist named Max Wyss of the University of Colorado who had embarked on a remarkable research project. As you will learn in our article, scientists have discovered that rocks go through a phase called dilatancy before an earthquake. This state affects the velocity of certain seismic waves through the rocks. Since the velocity change can be measured, the dilatant effect can be detected and the coming earthquake predicted.

The big problem with this is that large nets of seismographs would have to be set up in the earth's earthquake-prone regions to monitor the changing velocities and thus predict quakes. But Wyss reasoned that this might not be necessary in some spots. For years, he knew, seismographic stations in certain parts of the world have been keeping records of all seismic signals they receive. All that would be necessary, he figured, would be to examine records in past years and see if they showed any velocity changes prior to earthquakes. Wyss examined the past records from a seismic station near Matsushiro, Japan. And, he found before a swarm of earthquakes in 1965, there was the characteristic pattern of changing velocities.

The result is important for two reasons: First, it shows that scientists can now begin to examine records from all existing stations and see if any of the regions seem to be facing an imminent earthquake. Second, as Gilmore's story points out, the dilatancy prediction method so far had been shown to work on only one type of earthquake—the so-called thrust quake. But the Matsushiro swarm was on a strike-slip fault. Thus at least this one piece of evidence indicates that the method may be useful for all earthquakes, and not just for a portion of them as some scientists had feared.

Superconducting power lines

Scientists at the Atomic Energy Commission's Brookhaven National Laboratory (BNL) have reported the development of a more desirable form of niobium-tin superconducting material. They are working on superconducting power-transmission systems [PS, Oct. '72]. The new method involves inserting niobium in a bronze matrix followed by mechanical and thermal treatment to produce a better niobium-tin superconductor. The improvement comes in its performance at power-line frequencies. The new conductor has losses that are lower by a factor of six compared to previously available commercial niobium-tin.

Hubert P. Luckett

Editor-in-Chief

Mysteries of the giant planet with the Great Red Spot may be solved when our Pioneer 10 spacecraft whizzes past this month within one-diameter range

Our First Close Look at

By WERNHER von BRAUN
PS Consulting Editor, Space

This month a 13/4-year space voyage of more than a half-billion miles reaches its objective, and the exploration of the outer solar system begins, when a saucer-shaped NASA spacecraft flies past the gigantic planet Jupiter and its bevy of a dozen moons.

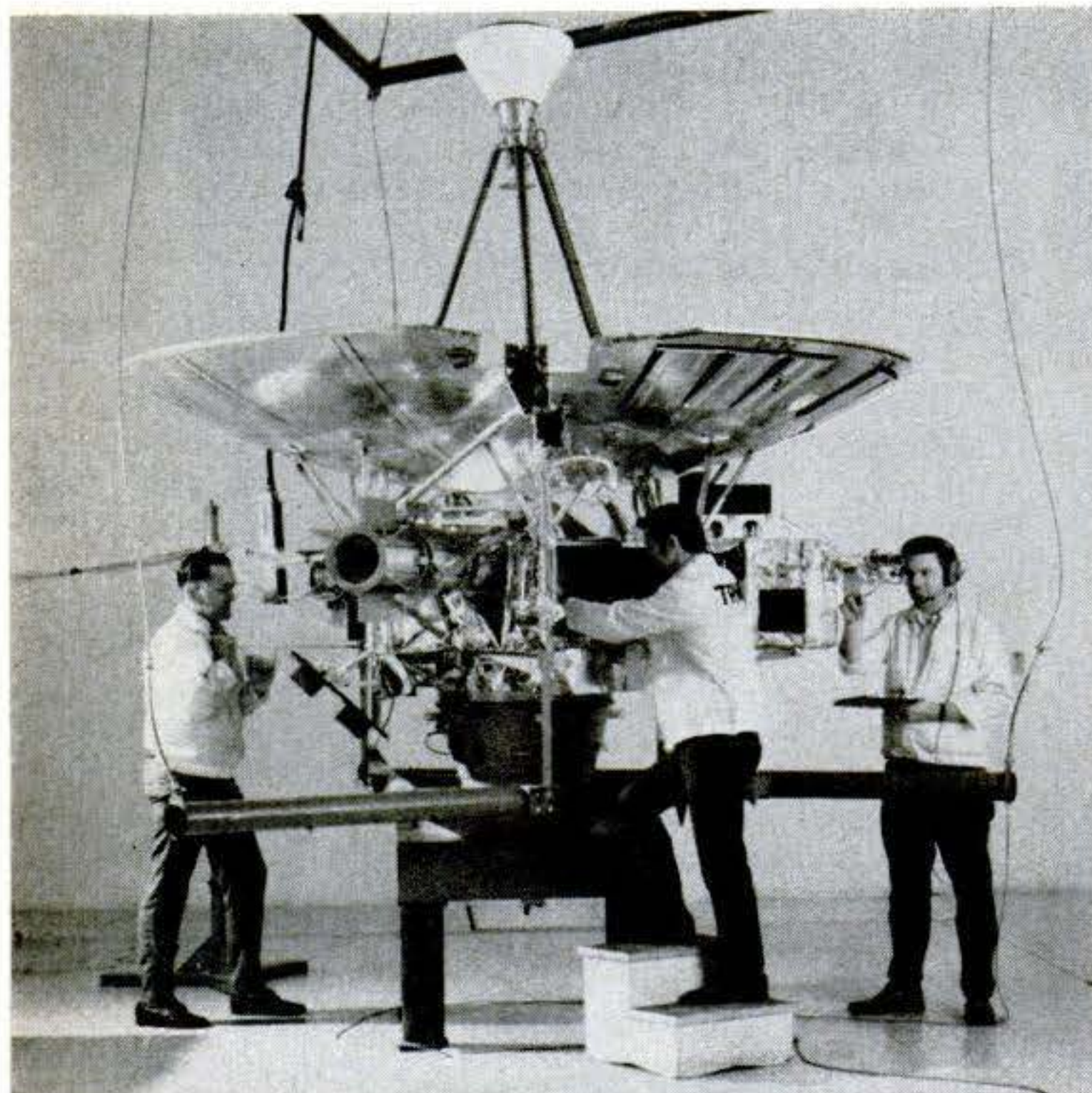
At nearest approach, on December 3, Pioneer 10 will skim within 81,000 miles of Jupiter—even closer than the maximum 88,900-mile diameter of the sun's biggest planet. From about 50 hours before to 50 hours after, its observing gear will go into all-out action.

First close-up pictures of Jupiter and its mysterious Great Red Spot are to be sent to Earth by an unconventional "camera" on the unmanned spacecraft. Instruments will seek answers to other riddles of a world whose exotic make-up rivals fantasies of science fiction. For example, Jupiter may consist largely of a metal never seen on earth—metallic hydrogen. Its atmosphere contains such strange constituents as methane (marsh gas) and ammonia—and excites students of our own Earth's past because it may be a surviving, observable counterpart of the Earth's primitive atmosphere around the time when terrestrial life began.

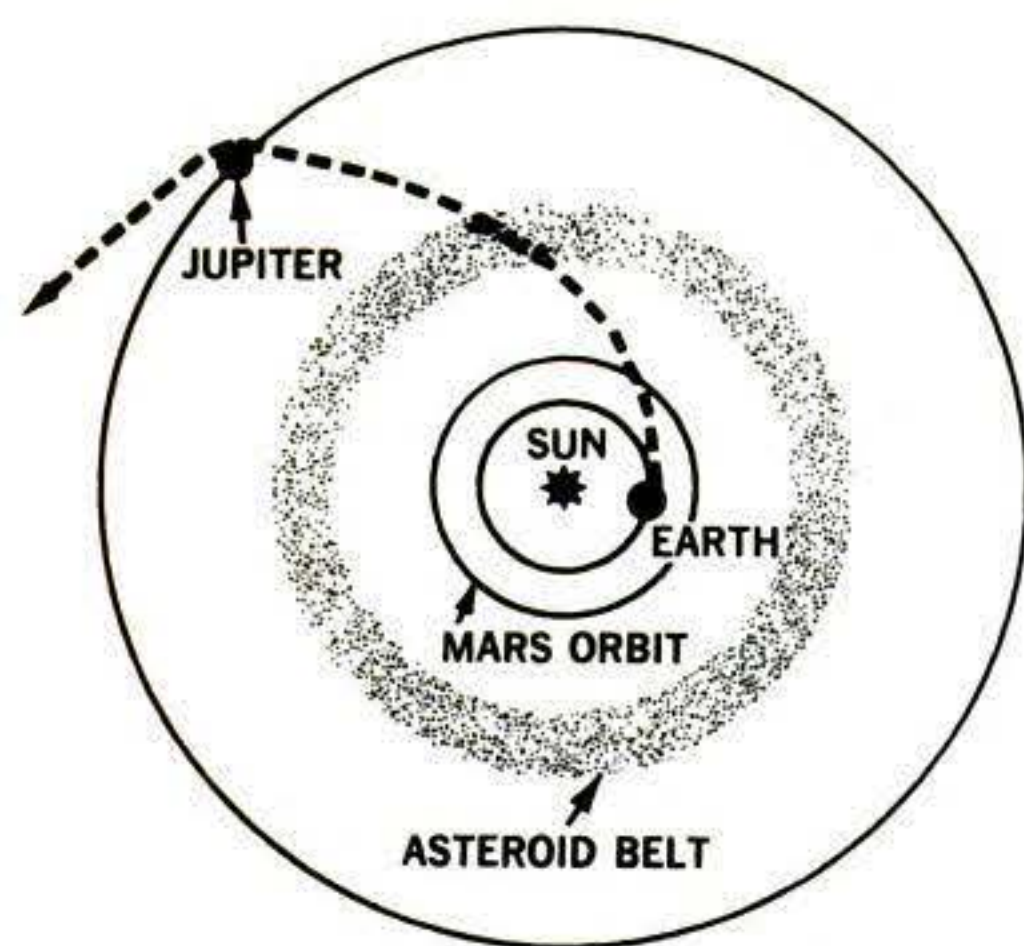
The Jupiter spacecraft. The space mission of Pioneer 10, built for NASA's Ames Research Center by TRW Systems, is the farthest ever attempted by man. So high are the propulsive requirements, 10 times as much energy per pound of spacecraft as for our 1971 Mariner to Mars, that the craft is necessarily small. Its 570-pound weight at launch was barely more than a quarter of the Mars Mariner's 2272 pounds. Its sparsely limited payload capacity for instruments totals only 66 pounds, against the Mars craft's comparatively lavish 150 pounds. But designers have met the challenge, with an array of exquisitely ingenious lightweight observing devices—consuming, all told, less power than a single 25-watt bulb!

A nine-foot-diameter dish antenna, to transmit its pictures and instrument readings back to Earth, dominates the exterior appearance of Pioneer 10. A tripod above the dish supports a small wider-angle antenna, for less-extreme range. Below the dish is the craft's hexagonal hub, with a boxlike instrument compartment attached to one side. Conspicuously absent is any such windmill-like array of solar panels as on our Mars spacecraft. The sun's rays are so feeble at Jupiter's distance that a prohibitive number of solar cells would be required. Instead, Pioneer 10 draws its electric power from an atomic source—plutonium-fueled radioisotope thermoelectric generators (RTGs) at the ends of two extending booms. They meet its maximum requirements of 108 watts of electricity.

A new three-stage rocket combination, an Atlas-Centaur plus a Thiokol solid-propellant third stage, launched Pioneer 10 in March 1972 at a record 32,000 mph. That was the velocity required for a journey so far that the signals of the craft's eight-watt radio transmitter will take almost 46 minutes to reach us from Jupiter, over the straight-line communication distance of 500 million miles. Pioneer 10's curving elliptical

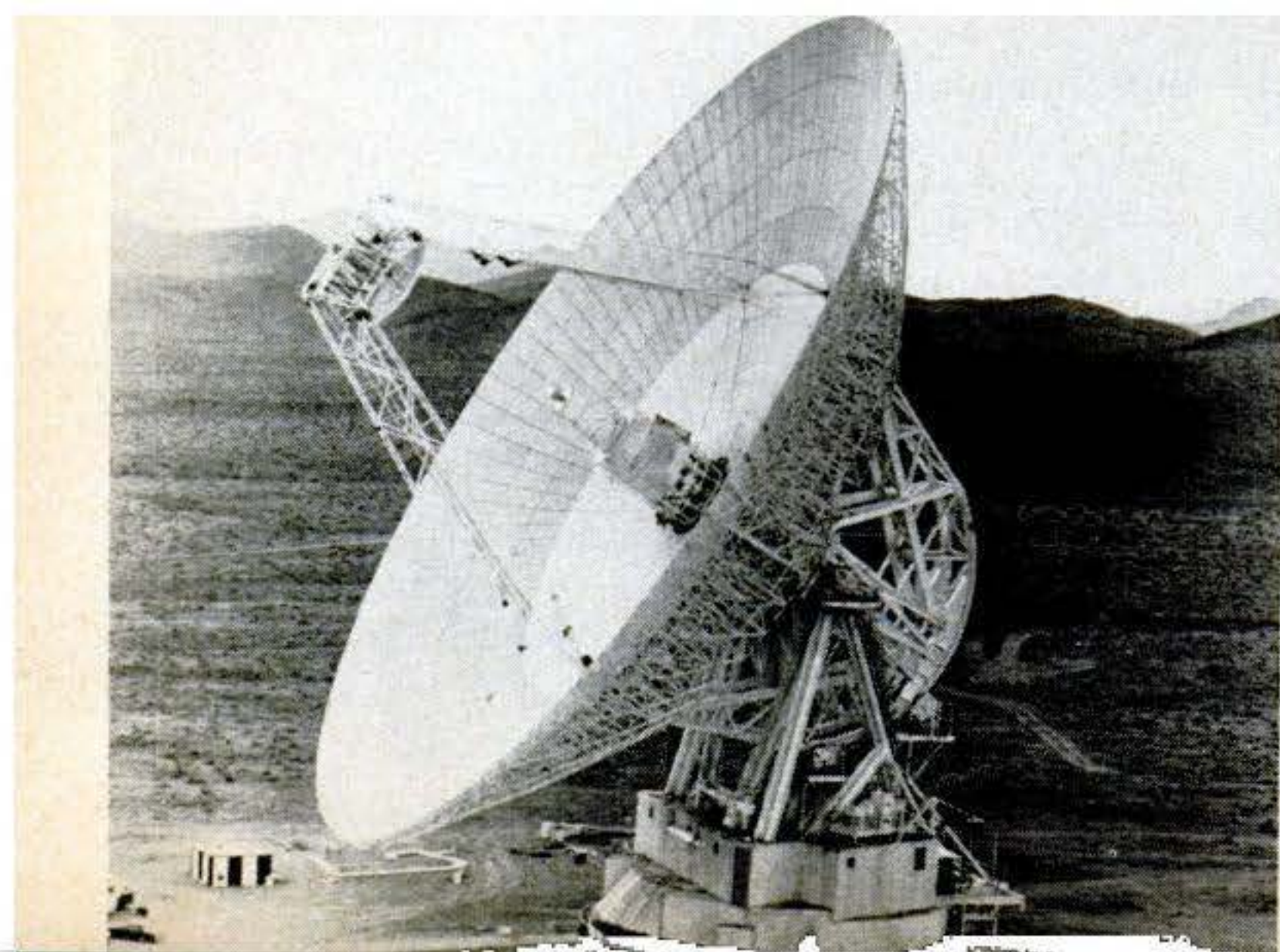


Pioneer 10 is readied by TRW technicians for 1/2-billion-mile voyage to Jupiter, arriving this Dec. 3. Nine-foot-diameter dish antenna will transmit to Earth what it sees.

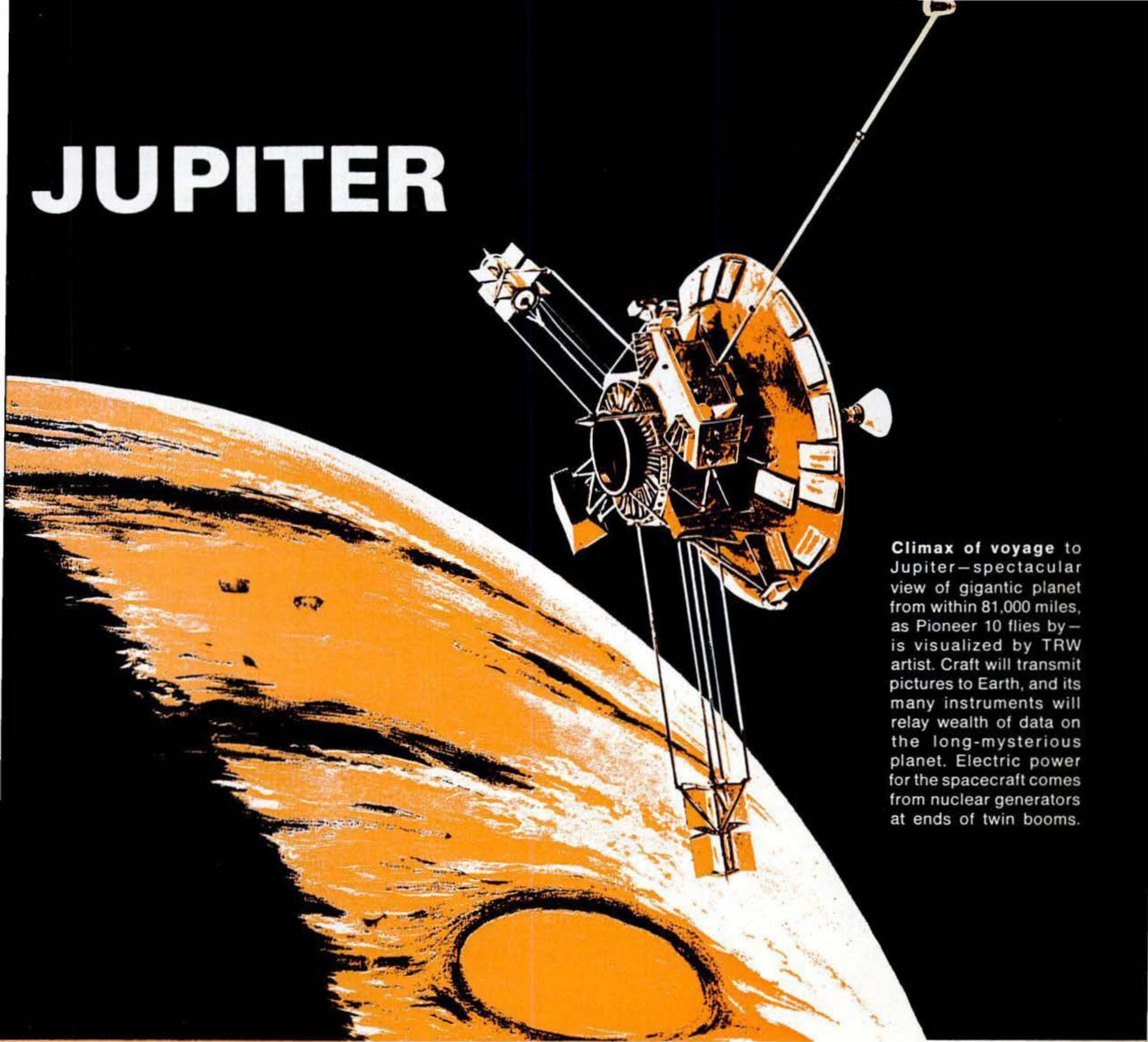


Course to Jupiter of Pioneers crosses Mars' orbit and Asteroid Belt, as shown. Pioneer 10 will swing wide of Saturn, but Pioneer 11 may be targeted to pass close to it.

Pioneers' reports on Jupiter will come in to 210-foot-diameter antennas like this big dish at Goldstone, Calif.



JUPITER



Climax of voyage to Jupiter—spectacular view of gigantic planet from within 81,000 miles, as Pioneer 10 flies by—is visualized by TRW artist. Craft will transmit pictures to Earth, and its many instruments will relay wealth of data on the long-mysterious planet. Electric power for the spacecraft comes from nuclear generators at ends of twin booms.

route will actually have taken it a lot farther, 620 million miles, to get there.

The view from Pioneer. As Pioneer 10 nears its target, Jupiter will swell to an eye-filling orb of awesome magnitude, exceeding 40 degrees in angular diameter—some 80 times as big across as the full moon

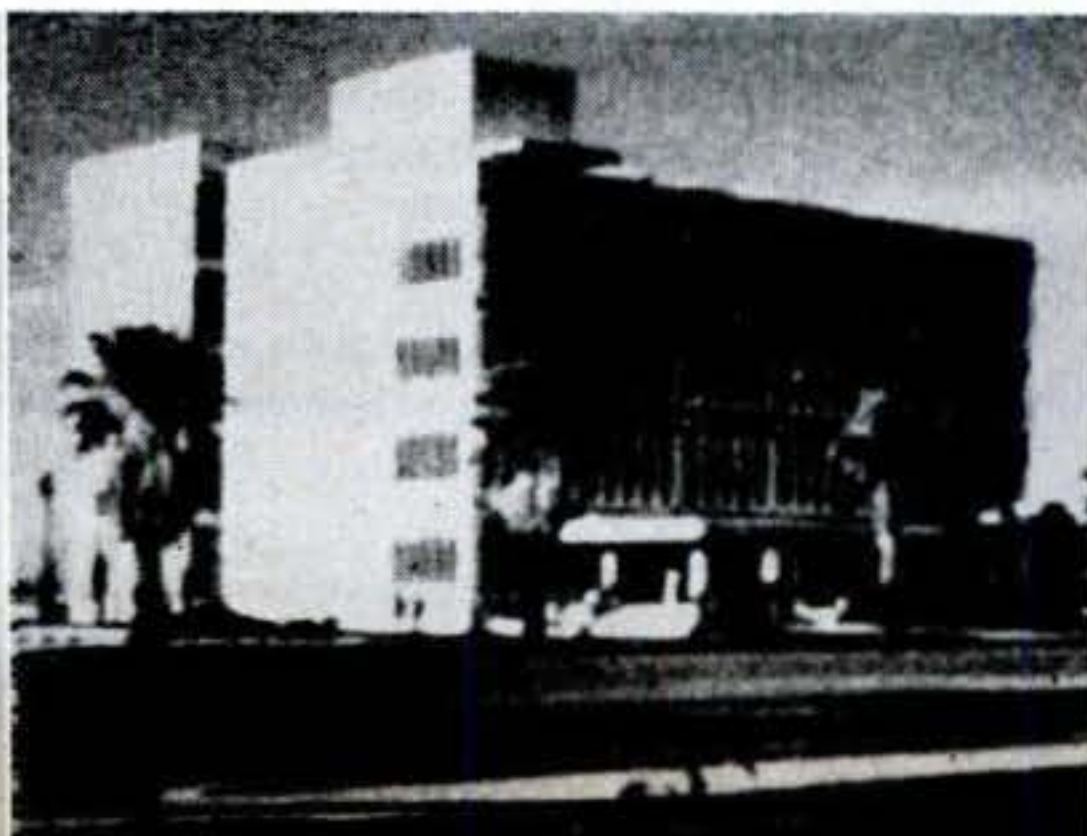
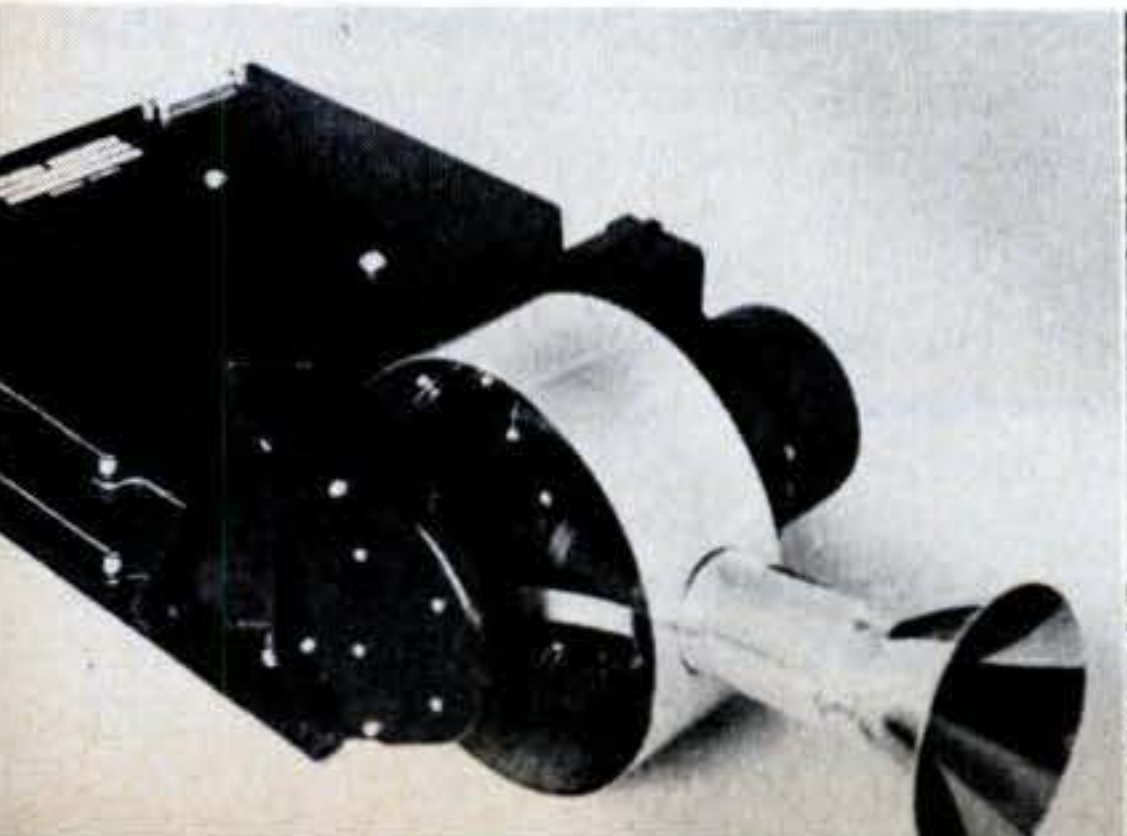
seen from Earth. As if graciously obliging a visitor who's come so far to see it, Jupiter will pirouette for inspection, making 10 complete revolutions during Pioneer 10's climactic 100 hours of observation; despite the planet's enormous bulk, it spins around in nine

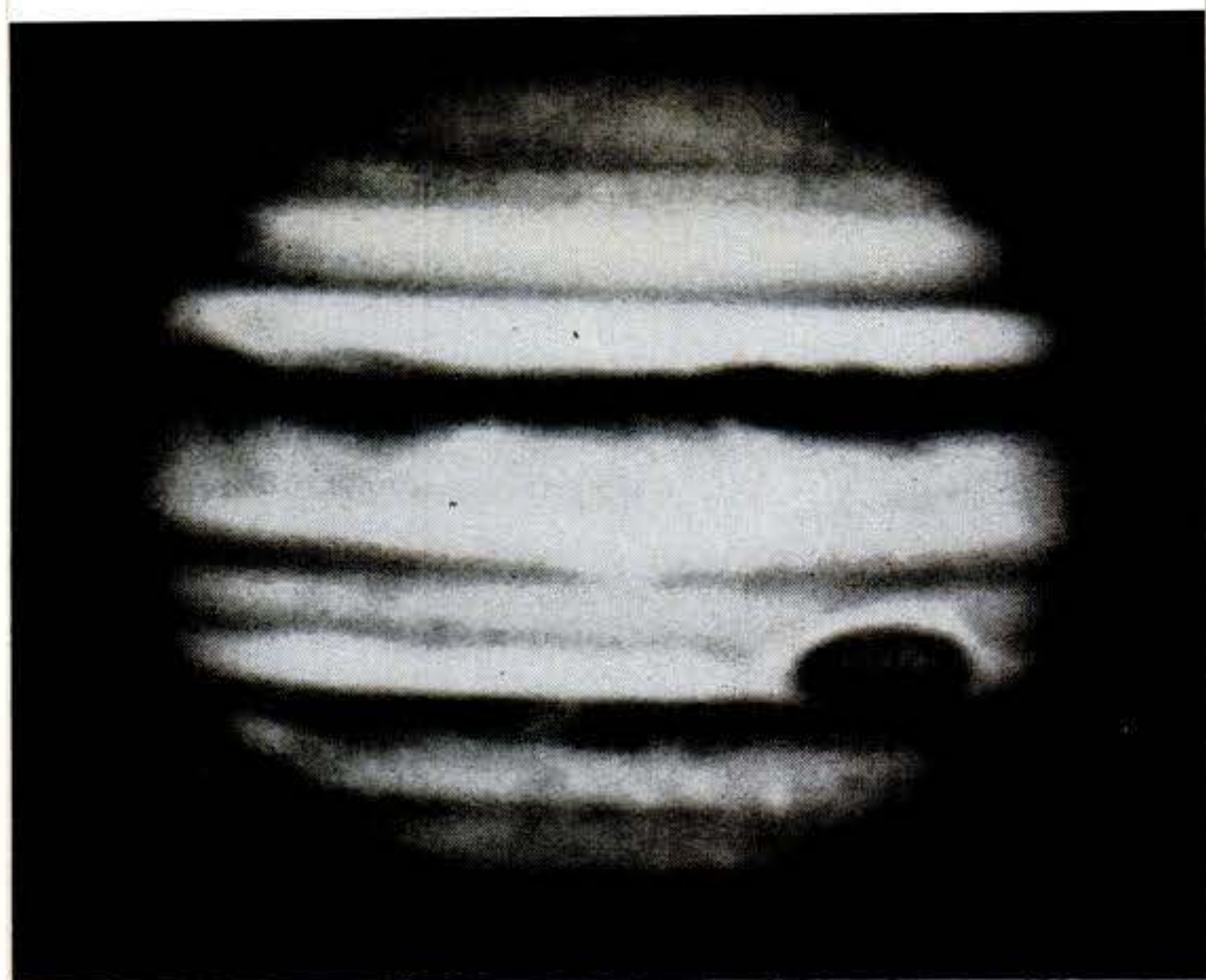
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"Camera" of Pioneer 10, called an imaging photopolarimeter, is a sophisticated nine-pound instrument. (Photo from Santa Barbara Research Center.)

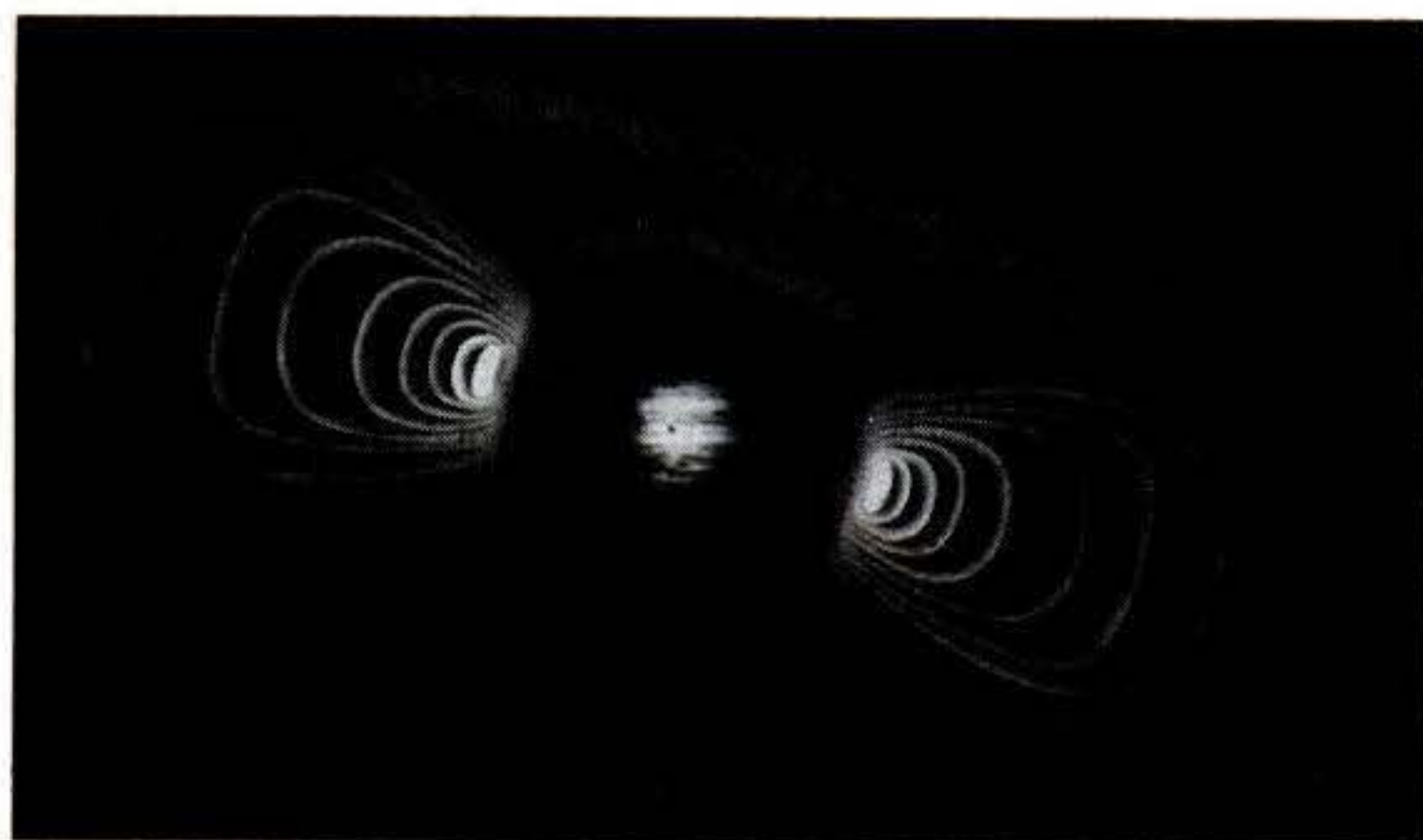
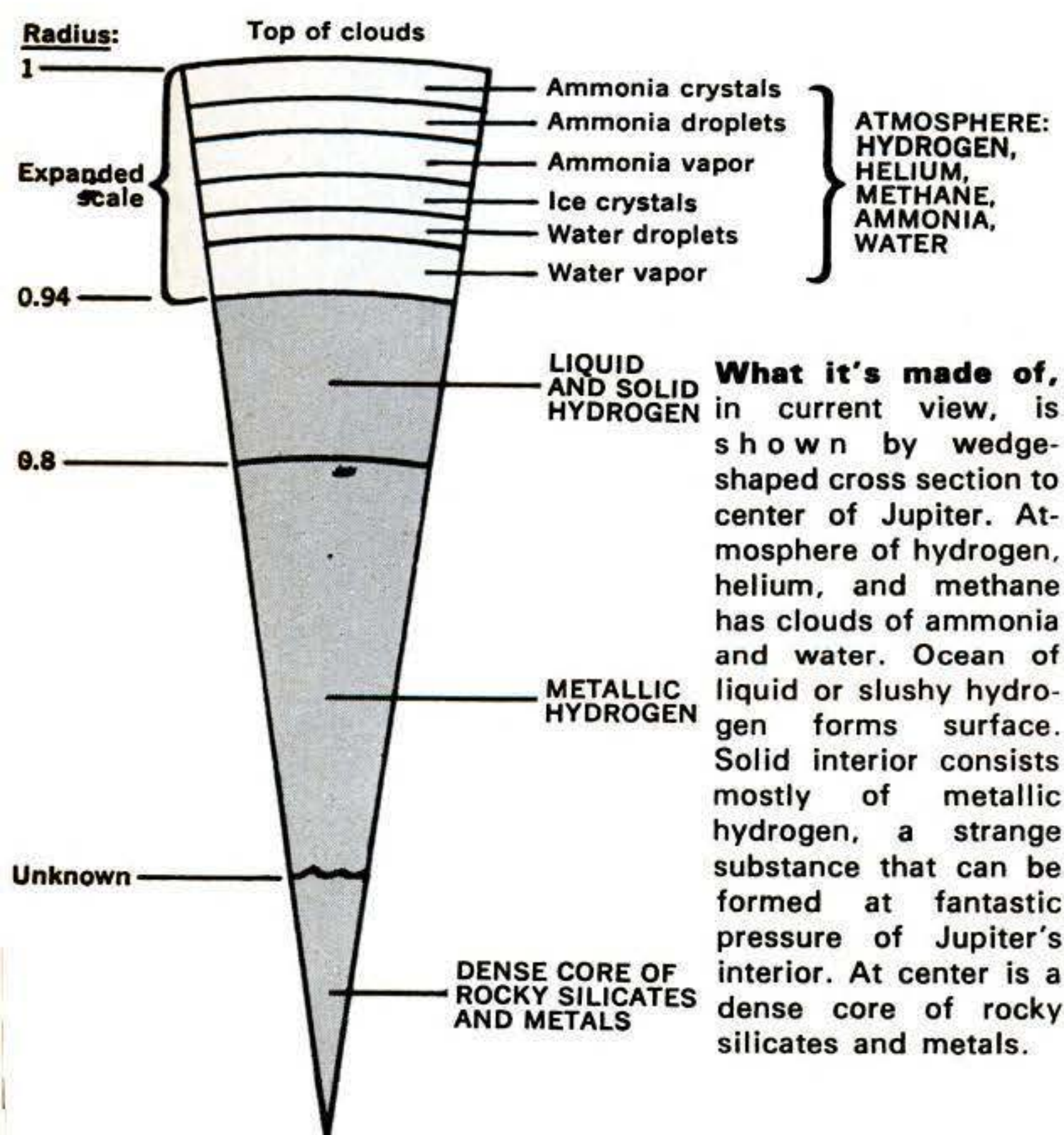
Pre-mission ground test of "camera" for Pioneer, at University of Arizona, produced photos of needed quality, like this one of optical-sciences building.

Simulated Pioneer photo of Jupiter, from NASA, gives preview of what actual pictures may look like. Details only 120 miles wide should be revealed.





Mysterious Jupiter, viewed from Earth with 200-inch telescope, has distinctive pattern of multicolored bands. Oval-shaped blotch at its lower right is the Great Red Spot.



Radiation belts of Jupiter, believed far more powerful than Van Allen belts of Earth, may menace Pioneer 10's instruments. If so, Pioneer 11 could give them wider berth.

hours and 55 minutes, less than half of Earth's 24 hours.

If you could be aboard the craft, you'd enjoy a spectacular view of features glimpsed before only through far-off telescopes. You'd see that Jupiter's face, golden in overall hue, actually has parallel stripes of bizarre and changeable colors. Sometimes there are slate-blue and pink bands; again, they may be gray, yellow, and orange. [Being in monochrome, the "fly-by" picture on the preceding page of course is not realistic as to colors.—*The Editors.*] The fleeting tints are not on Jupiter's surface, but are windborne in its atmosphere. For clues to what makes them, Pioneer 10's pictures will be eagerly scanned.

Colorful and changeable, too, is Jupiter's most famous mystery—the oval-shaped Great Red Spot, some 30,000 miles long, in its South Tropical Zone. Brick-red or carmine when most conspicuous, it sometimes fades to a pinkish shade or gray and becomes faint. Since it wanders about in longitude (though not in latitude), it seemingly must be a floating disturbance, of some unknown kind. Scientists hope they will soon see the most revealing photographs of it ever made.

The "camera." Pioneer 10 will take its pictures with a diminutive instrument called an imaging photopolarimeter. Although it weighs only 9.1 pounds, in contrast with the Mars Mariner's 57-pound pair of TV cameras, its advanced technology promises well for its results. It will eye Jupiter through a pointable one-inch-aperture telescope that protrudes from the side of the spacecraft.

The craft's own rotation to stabilize itself in flight, at about five rpm, will cause the telescope to scan the face of the planet. Thus the instrument will build up television-like images of Jupiter. Like Pioneer's other instruments, it will transmit what it observes to Earth in the form of a stream of digits. From these numbers, technicians on Earth will be able to reconstruct pictures of Jupiter, both by red and blue light (a gauge to coloring), with sharp enough resolution to distinguish features 120 miles across.

Fly-by pictures of Jupiter's cloud patterns possibly may reveal wind speeds, convective motions, and symmetries in the flows—key data for investigating the planet's atmosphere and weather. That might help to test the validity of one of the most intriguing theories for the tinted bands—that the colors are those of *organic* chemicals, synthesized from the methane, ammonia, and water in Jupiter's atmosphere by lightning or sunlight. Organic chemicals of similar hues have been produced on Earth, by electric discharges and by ultraviolet light, in laboratory experiments with a simulated Jupiter atmosphere.

The presence of organic chemicals would be no proof of life on Jupiter—but, in an atmosphere believed like that of the primeval Earth, they could represent initial steps toward the appearance of life. So if Jupiter's colors really do come from organic chemicals, some believe, the simplest forms of life may already have appeared on that planet. Such primitive organisms might be suspended in certain layers of Jupiter's atmosphere, just as algae and protozoa are suspended in the Earth's oceans. Contrary to earlier belief that Jupiter was too cold to support life, recent opinion holds that some levels of its atmosphere may be as warm as a summerlike 80 degrees F.

Taking Jupiter's temperature. Facts will replace conjecture when two Pioneer instruments, an ultraviolet photometer and an infrared radiometer, map Jupiter temperatures and search for hot spots in its upper atmosphere. The variety of things they'll tell illustrates scientists' knack of deducing a wealth of information,

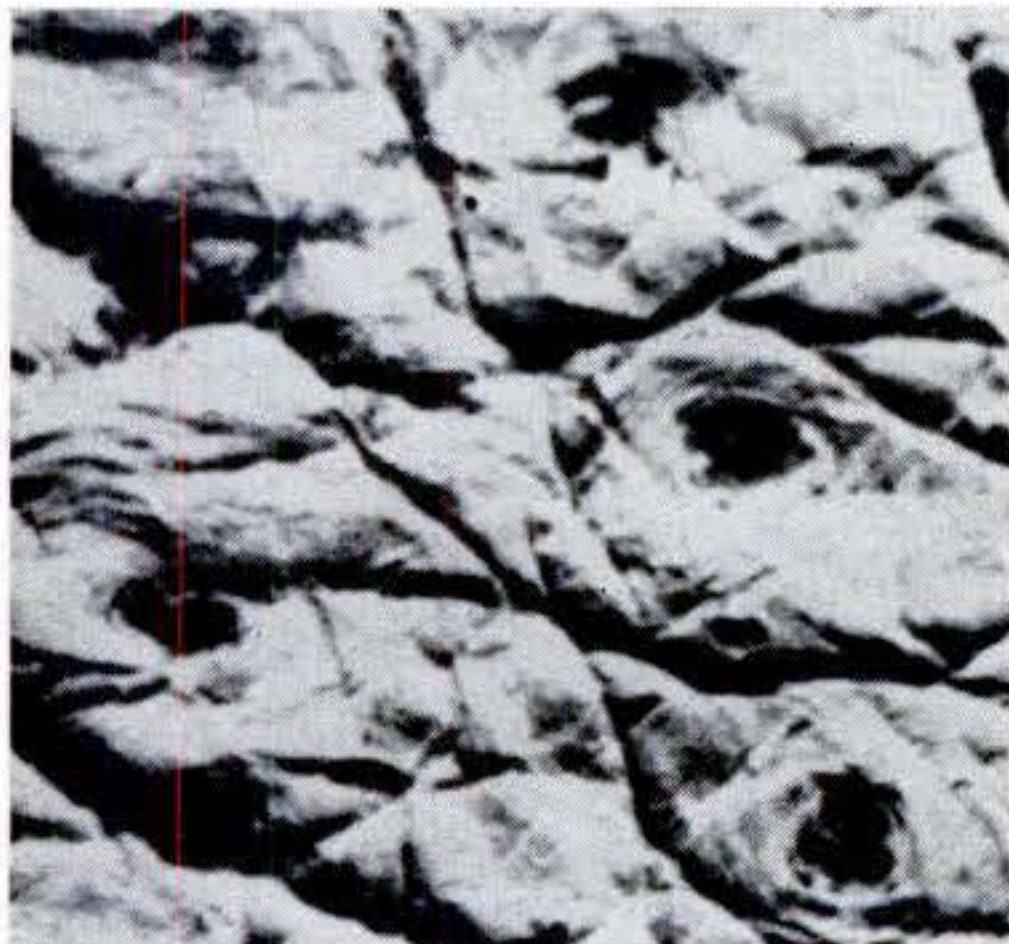
[Continued on page 138]

PS Guide to the New Electric Shavers

Thinking of giving up wet shaving? Or trading in that old electric? Come along with PS' test panel for a look at the more popular beard mowers

By DOUG GARR
PHOTOS BY ORLANDO GUERRA

How do you go about picking the best electric razor for your beard and face? The job hasn't been made any easier by all those conflicting ad claims. Recently Schick stuck its beard out and claimed its razor shaved closer than Norelco, Remington, and Sunbeam. Ronson, smarting from the fact that it wasn't even included in the comparison, suggested in ads that if Ronson were included, Schick wouldn't have been able to make the claim. Remington got into the act by suing Schick for damages resulting from



Schick photo of man's chin magnified 600 times shows what beard looks like after electric shave. Holes are where whiskers (0.005-inch diameter) were.

New electric shavers come in many shapes and sizes. PS test panel thought most types were much better than previous models in regard to closeness and

misleading and false advertisements.

Schick's comparative ads are being scrutinized, as we go to press, by the National Advertising Review Board, a watchdog agency formed two years ago to make sure manufacturers don't get overzealous in their ads. But even that decision may not answer the question: "Which razor gives the closest shave?"

The problem? There are no standardized test controls that each company must follow. The shaver makers send off their razors to independent testing labs, wait for the results, and publish the favorable ones. It's conceivable that they're all "right."

The PS panel. Since shaving is so subjective, we assembled our own 10-man test panel to try out 14 different models. Some hundreds of shaves later we agreed on previous test findings: Personal preference differs widely. It's impossible to pick

comfort. Panel felt most trimmers were inadequate. Noise and vibration were complaints most often noted on many models during 200-plus shave test.

a best or worst shaver. What's great on one guy's whiskers is sheer misery on another's.

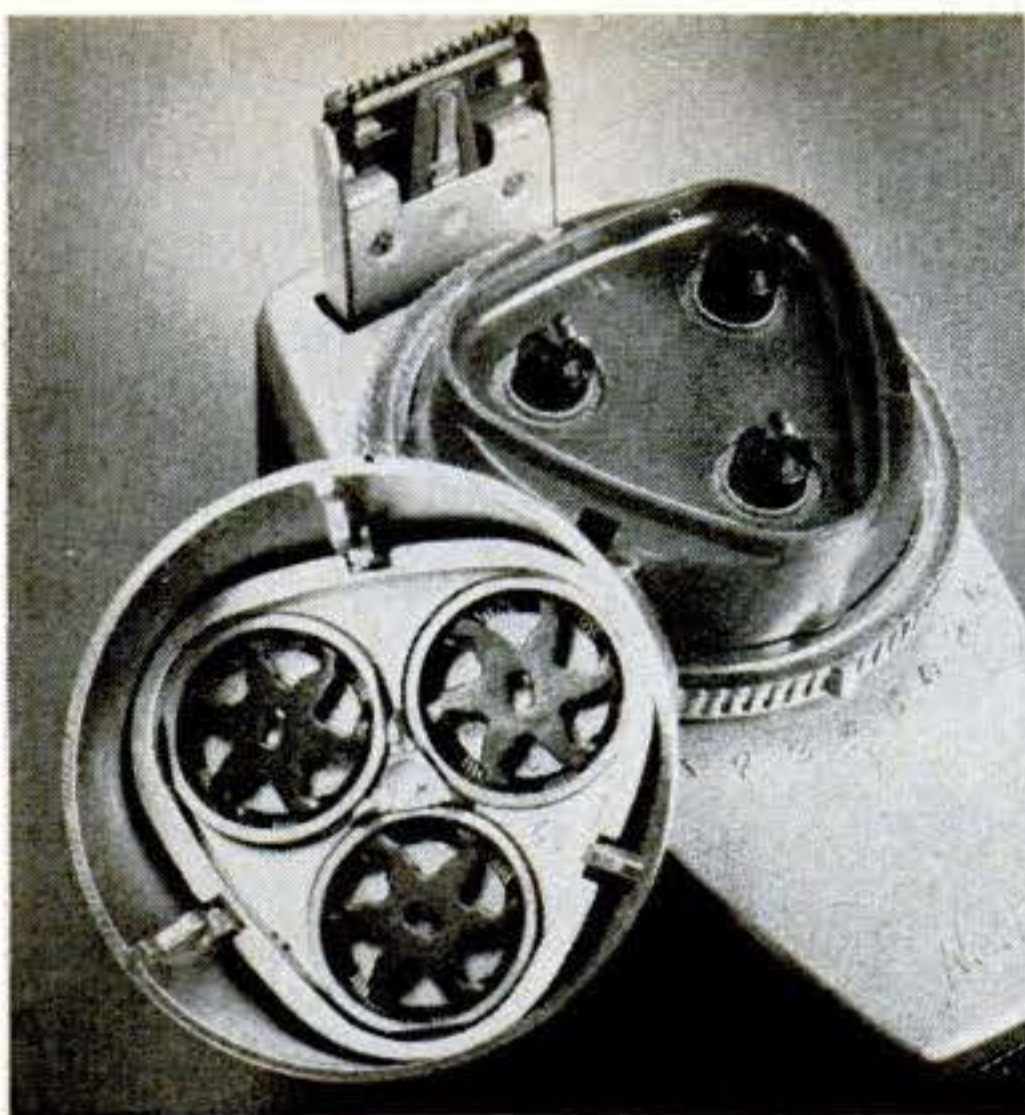
Also, a "good" shave takes into account lots more than closeness. Our users tried the shavers for speed, trimming, freedom from pulling and irritation (comfort), handling feel, and cleaning difficulty.

First, a word about how electric shavers work. Basically, there's a series of carbon or stainless-steel blades (also called cutters) that oscillate or rotate under a metal guard (called a foil, comb, or head, depending on the company) with tiny holes in it. When a whisker penetrates a hole, the head pushes down the skin area surrounding the follicle, exposing it, and a blade whirrs by and slashes it off. (Hence Norelco's claim that its razors shave "below skin level.")

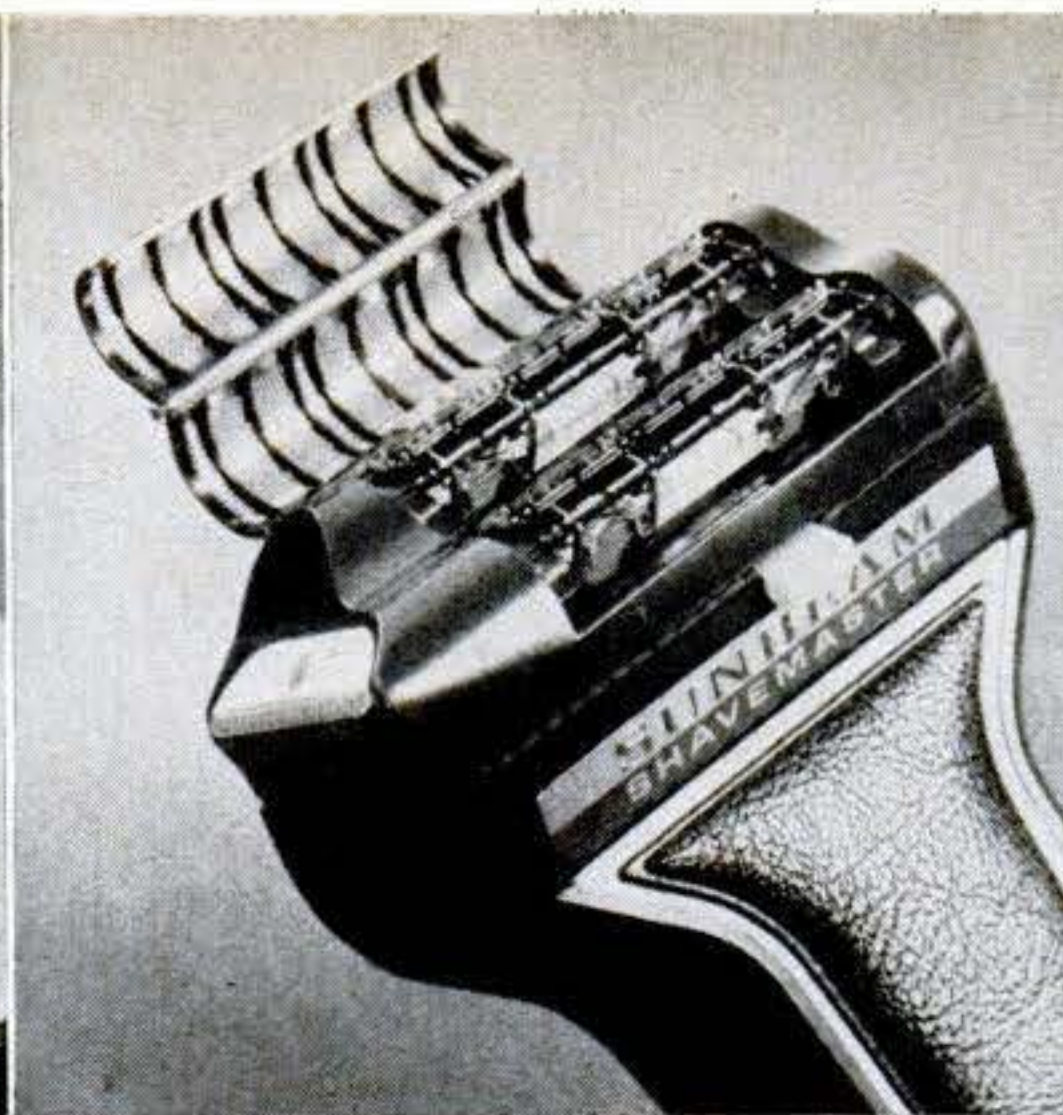
A typical shaver has either a ro-

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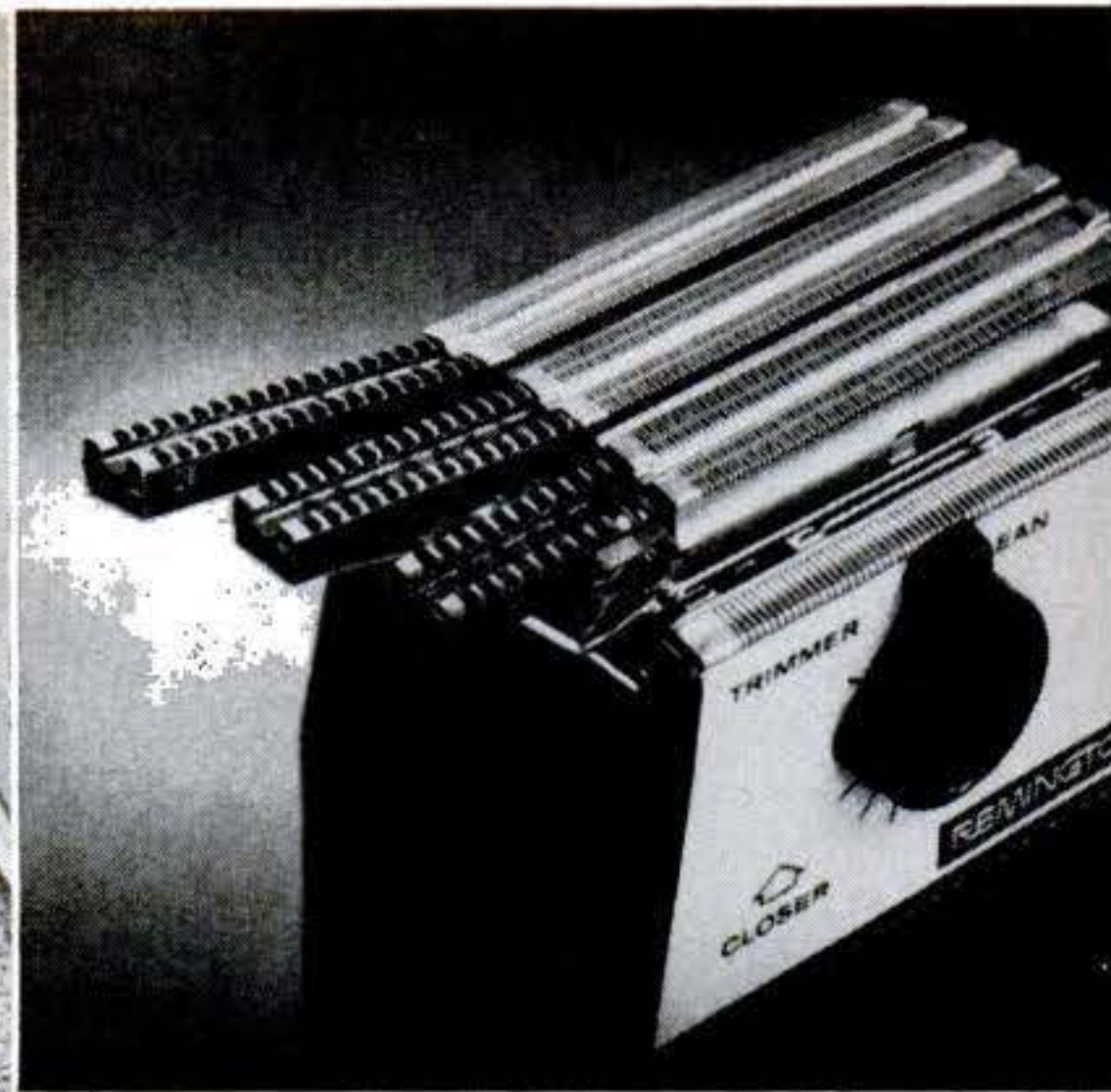




Norelco 40 VIP head removes for fast and easy cleaning. Head contains three rotary blades with six cutters each.



Sunbeam SM-7 head pops open for cleaning. The shaver has six elongated self-sharpening carbon-steel blades.



All Remington shavers use flat head, which pops up for cleaning and trimming. Remingtons have three sets of blades.

tary (about 5000 rpm) or reciprocator/vibrator motor with a 7000- to 10,000-vibration-per-minute frequency. Most companies have cordless options with rechargeable ni-cad batteries. Some have 110/220-volt converters for overseas shaving. Trimmers, mostly retractable, are available to cope with today's invogue sideburns, complex beards, and mustaches. You'll find shavers with as many as nine closeness/com-

fort settings, some with four or five, most with none.

The biggest difference among makes is in head design. There are three types: rotary, foil, and flat (or slot). Most popular is the foil, which features a cylindrical, flexible comb. Ronson, Schick, and Sunbeam use this system. Remington uses the slot, with three sticks of blades side by side. Norelco has a flexible rotary head with circular blades.

The amount of surface area touching your face generally affects shaving speed. What's fastest you can't say. Flexible foils and rotary heads roll with the contours of your face. The slot head isn't flexible, but has more surface area on your face at a given time.

Closeness. This seems to be the biggest criterion for a good shave. You test for closeness by simply rubbing your face after you mow down your beard. The less stubbly it feels, the closer it is. Even one shaver maker admits it's more important than any test results.

Closeness is directly proportional to how much cutter gets to your whiskers. If a razor has adjustability, the closer the blade gets to the head, the closer your shave will be.

But closeness is inversely proportional to comfort. Dr. Herbert Mescon, chairman of the dermatology department at Boston University Medical School, says, "The amount of irritation you experience depends on how energetic a shaver you are." The harder you press, the greater your susceptibility to irritation.

Interestingly, you remove some epidermis—the outer layer of skin—from your face each time you shave. Dr. Mescon's tests with both electric and blade shavers showed follicles, oil, and moisture removed as well as epidermis each time a tester shaved. Removing too much epi-

dermis causes redness—irritation.

Irritation is most prominent in the neck area around your shirt collar. This is due, says Dr. Mescon, to the "looseness" of the skin and also because the hairs don't grow perpendicular to the skin surface, but bend over sideways. To get a close shave in this area, the user tends to press harder—usually against the grain—resulting in irritation.

Blade vs. electric. Most Americans still prefer wet shaving to dry, probably because blades tend to shave closer and faster. Electrics also represent a fairly hefty initial investment.

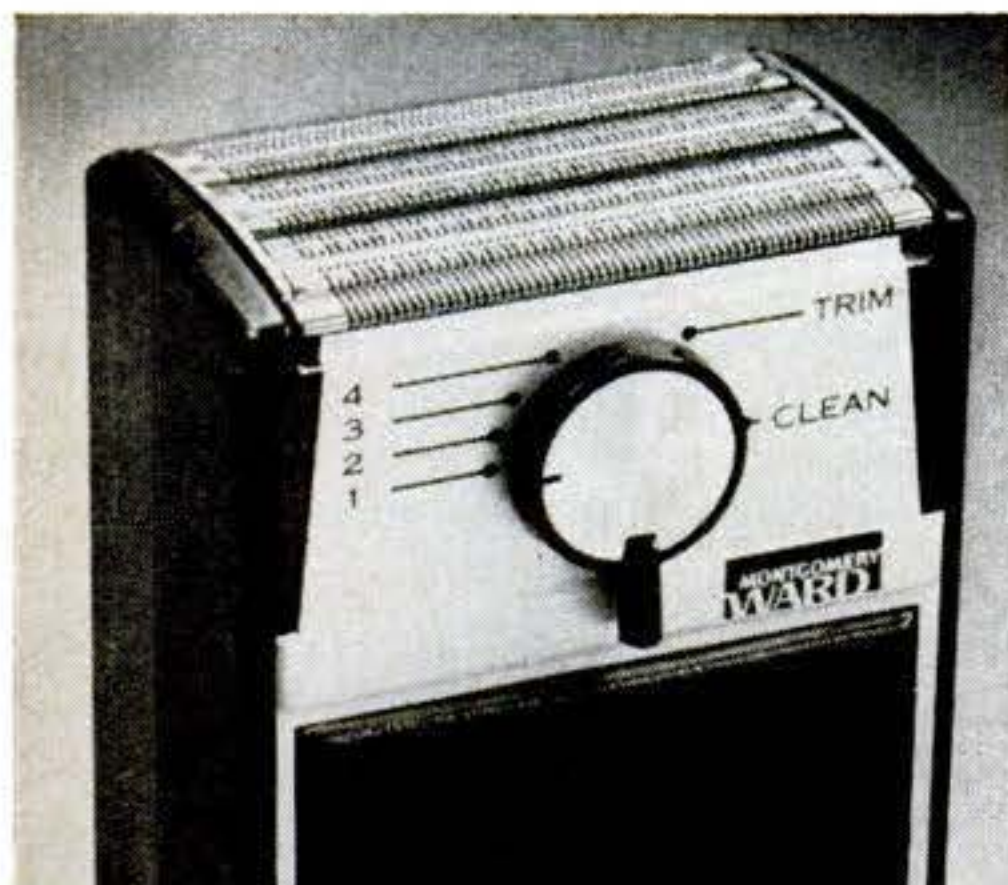
Norelco says only 15 percent of the U.S. shaving population uses electrics, while Remington's figures put it at 30 percent.

Norelco's studies show that it's cheaper to shave with an electric than a safety razor if you spread the cost over a period of 2½ years.

Some maintenance is required with electric razors. You must clean the head after each shave, lest you clog the cutters and reduce their efficiency. Liquid cleaners are available for more thorough cleanings. Blades should be replaced, generally, after six months, but this depends on how tough your beard is and how much you shave. If shaving is taking longer than usual, it's probably time for a new set. Some companies recommend replacing the head every year, too. If you drop your razor and dent the head even slightly, you should change it. A damaged head causes pinching and pulling.

Vibrator motors, the type most commonly used, are virtually maintenance-free. On its rotary motor, Norelco recommends getting the carbon brushes changed and the motor lubricated after five years.

Switching to electric. Most shaver makers suggest spending three to



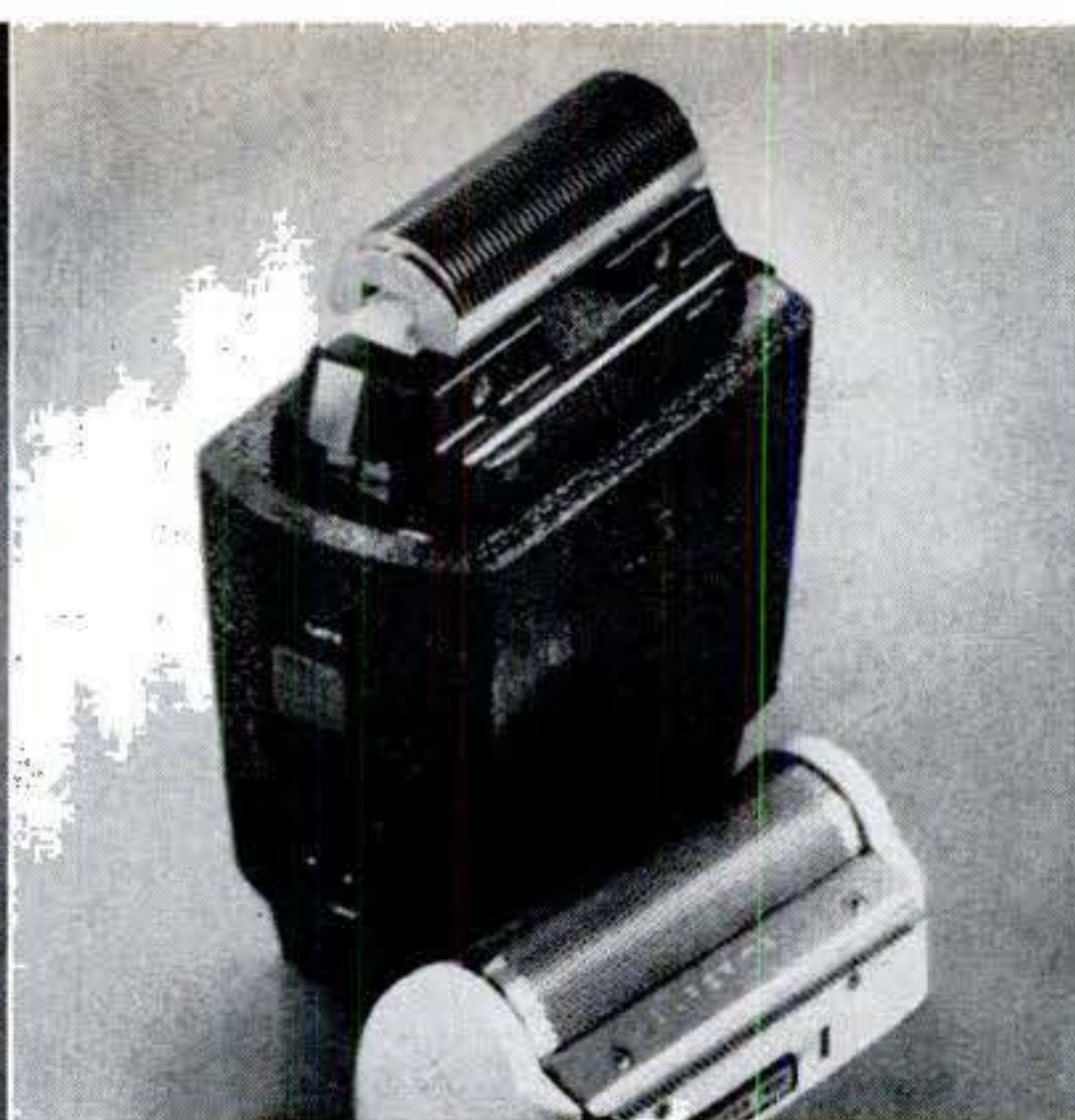
Montgomery Ward's TR-7 uses flat head very much like Remington's. This model is rechargeable.



Oster Professional has twin-foil head and cutter assembly with 72 stainless-steel blades. Trimmer is on side.



Schick head opens at flip of switch for convenient cleaning. The cutter assembly of this shaver contains 34 blades.



Ronson 1000 has head assembly similar to Schick, but head comes off completely. Foil is featured on most shavers.



Sears Craftsman is only model with dual heads. Trimmer head (right) worked better than any other on styled beards.

four weeks getting used to an electric if you're converting from wet shaving. Schick dealers let you try out their razor. If you buy one and don't like it after two weeks, you can return it. Sunbeam has a 10-day trial period with a money-back guarantee if unsatisfied. But if it takes nearly a month to get used to one, brief

trial periods won't do you much good. Best bet is to test a friend's razor for three or four weeks.

If you do go electric and have trouble getting a comfortable shave, you may want to try a preshave lotion. Eighty-percent alcohol (the rest are fragrances and lubricants), preshaves reduce friction on your

face and lubricate the cutter system.

Many of the higher-priced shavers have extra features like cordlessness, more comfort settings, faster motor, charge light, 220-volt options.

Expect to pay between \$18 and \$50 for an electric. But shop around; they're discounted heavily, just like stereo components. **PS**

What the PS test panel found out after shaving with 14 models

After three weeks of test-shaving, the PS panel concluded that, overall, the shavers were much improved in closeness and comfort since our last test in July, 1969. Blade users generally thought they could still get a closer shave with wet shaving, possibly because safety razors have one or two blades in direct contact with your skin.

The biggest complaints were with noise, vibration, and trimming. (See chart for noise-level test results, made six inches from shavers on A, B, and C scales.) Vibration and noise seem to go together; a noisy razor often shook a lot. One user thought the Ronson Cobra Cordless vibrated too much and was noisy. Several users thought the Schick 400 was excessively noisy, too. But they also felt the Schick 900 was quieter than the 400. The Remington Mark I and III and the Sears Rotomatic earned praise for quietness.

Trimming ease with electrics hasn't improved much. Many users faulted nearly all the trimmers as being ineffective. Exceptions were the Norelco 35T, Oster, and Sears Craftsman, which were lauded for their mustache- and beard-trimming ability. The Sears Craftsman has a dual head: one for shaving

close, one just for trimming. One tester said the Sears trimmer head was the best he had tried on his beard. Shaving near sideburns is especially difficult, partly, at least, because of lack of a clear line of sight. It's hard to see what you're doing, especially with the Norelcos.

Handling feel brought a few comments. Most liked the way the Oster felt; some thought the Ronson Cobra Cordless awkward. The Ronson 1000 was cited for being "pleasantly compact and lightweight."

Our panel thought the Remingtons were all easy to clean, along with the Sunbeam Shavemasters and Schick Flexamatics. The Oster and Ronson 1000 were troublesome to clean.

Some users complained about the bulkiness of converters and shaver stands, but this didn't seem to be a big problem. Testers liked cordless convenience and complained mildly about too-short coil cords, and converters on outlets that could fall out and get damaged on the floor.

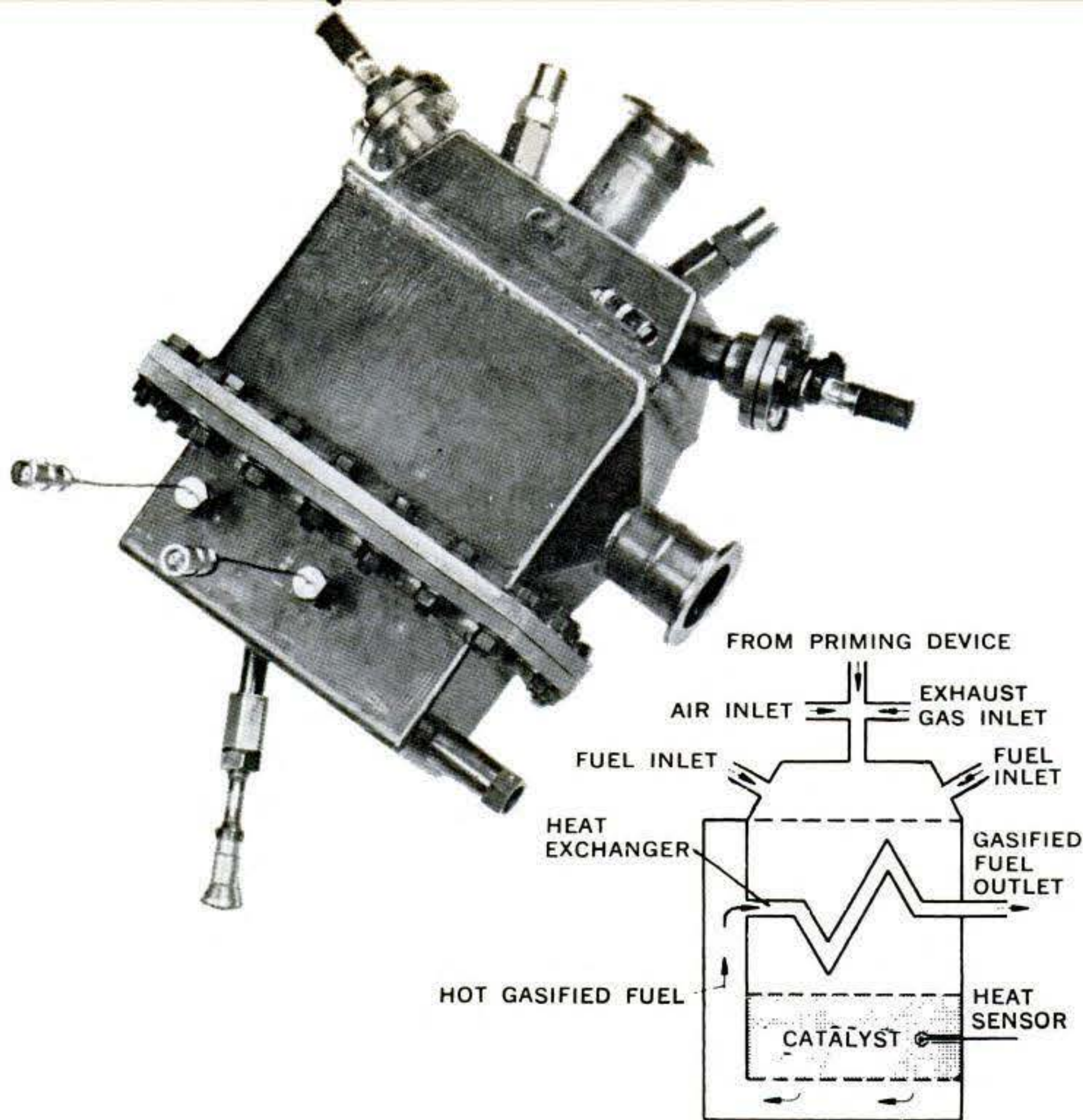
Another complaint was the problem of knowing how much charge was left on cordless models. A less-than-normal charge takes longer to shave and is uncomfortable due to pulling.

Electric shavers—how they compare	Type head	Trimmer size (in.)	Type motor	Cord or cordless	Adjustability	Noise test (dB)			List price	Remarks
						A	B	C		
Sunbeam SM-7	Foil	1 3/8	Vibrator	Cord	No	83	82	82	\$35.50	
Sunbeam SM-8	Foil	1 3/8	Vibrator	Cordless	No	84	83	83.5	44.95	
Remington MK I	Slot	1 7/8	Vibrator	Cord	Yes(4)	74	76	75	22.95	Head pops up for trim
Remington MK III	Slot	1 7/8	Vibrator	Cord	Yes(4)	72	72	75	28.95	Extra blades included
Ronson 1000	Foil	1 3/4	Vibrator	Cord	No	78	78	79	24.95	Extra head and blades
Ronson Cobra	Foil	1 3/4	Vibrator	Cordless	No	79	80.5	80	44.95	120/140 volt, charge light
Norelco 35T	Rotary	7/8	Rotary	Cord	No	81	80	81	34.95	110/120 volt
Norelco 40 VIP	Rotary	7/8	Rotary	Cord	Yes(9)	86	86	86.5	39.95	120/220 volt
Schick 400	Foil	1 5/8	Vibrator	Cord	No	75	75.5	77	39.95	
Schick 900	Foil	1 5/8	Rotary	Cordless	No	77	76.5	77.5	44.95	
Sears Electra	Foil	1 3/4	Vibrator	Cord	No	86.5	85	86.5	18.99	Dual head; one for trim
Sears Rotomatic	Rotary	7/8	Rotary	Cord	No	79	77	79	18.99	
Ward's TR-7	Slot	1 7/8	Vibrator	Cordless	Yes(4)	87	85	84	29.77	
Oster	Foil	7/8	Vibrator	Cord	No	76.5	76.5	78	19.95	

Siemens Catalytic Carburetor Gives Cleaner Exhaust

New fuel system creates very lean mixture for low emissions and improved fuel economy

By JAN P. NORBYE
PS Automotive Editor



A small box about 12 inches high encloses the carburetor unit. The diagram at right shows the flow path of the gaseous fuel from the catalyst bed through the built-in heat exchanger. Fuel is metered by electronic computer.

As you know, Detroit is taking steps to fit catalytic converters on '75-model cars for sale in California, and may use similar systems on *all* future models. Those catalytic converters are part of the exhaust system—they trigger a chemical reaction in the fumes, turning pollutants into harmless vapors.

This Siemens development uses a completely different catalyst, in a very different way. It prepares the fuel charge for combustion. Siemens is a German industrial giant with activities about as widespread as General Electric's. The Siemens research laboratories in Erlangen have been studying fuel systems for some years, and have now revealed their catalytic carburetor.

Perhaps it's inaccurate to call it a carburetor. It's a gas generator that breaks up the gasoline molecules into gaseous components such as hydrogen, carbon monoxide, and methane before the fuel is mixed with air. Some air is necessary for the gasification process, but the ratio is one part air, by weight, to 20 parts gasoline.

How does it work? As the sketch above shows, fuel is metered by electromagnetically controlled injectors, and enters from both sides at the top. A priming device feeds

in small amounts of air mixed with recirculating exhaust gas. The fuel enters the catalyst bed and is gasified in a cracking process. The purpose for recirculating the exhaust is to heat up the catalyst. It will not work below a certain temperature. Siemens engineers won't identify the catalyst, but claim it contains no noble metals.

The gas is formed at several hundred degrees and must be cooled before it can be mixed with air. The cooling takes place in two stages. First, the gas flows through a heat exchanger contained within the carburetor body. Some heat is recovered and goes back to the catalytic bed. Then the gas flows through a water-cooled radiator before it's led to the mixing unit.

The air/fuel charge is created in the mixing unit, when the gasified fuel is metered into fresh air that has entered the plenum chamber mounted upstream from the mixing unit and intake manifold. The air/fuel ratio is closely controlled by an electronic control unit.

This small computer also controls the priming device and the quantity of raw fuel admitted to the catalytic carburetor. The computer is wired to sensors for engine speed and load, ambient temperature, and air densi-

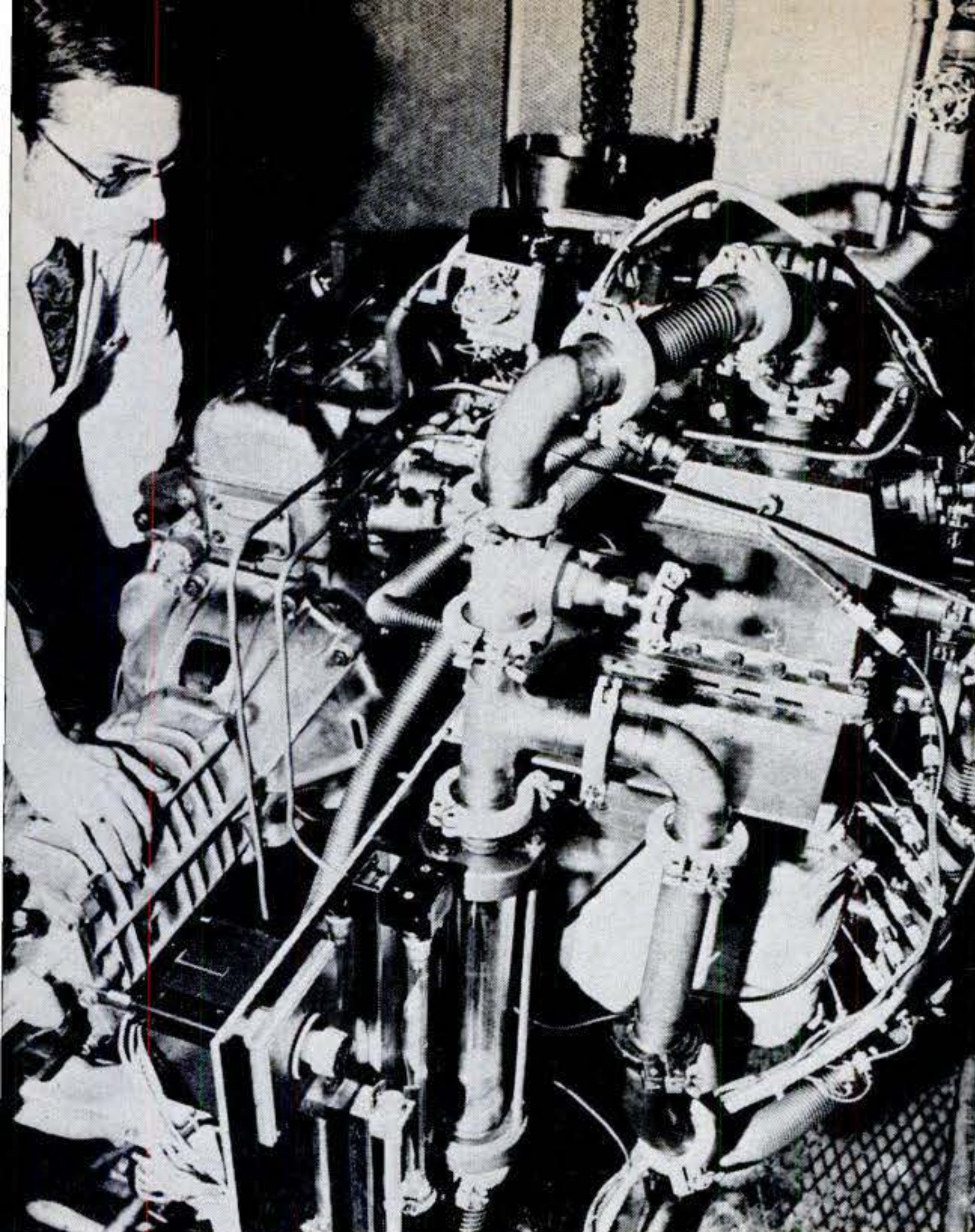
ty, and automatically adjusts fuel quantity and air/fuel ratios as incoming information is received. Adjustments are made in milliseconds.

Despite the intercooling, the air/fuel mixture still has a higher-than-ambient temperature when it enters the combustion chambers. This brings with it the disadvantage of reduced cylinder filling. Siemens engineers estimate that the catalytic carburetor gives volumetric efficiency between 10 and 20 percent lower than conventional carburetors.

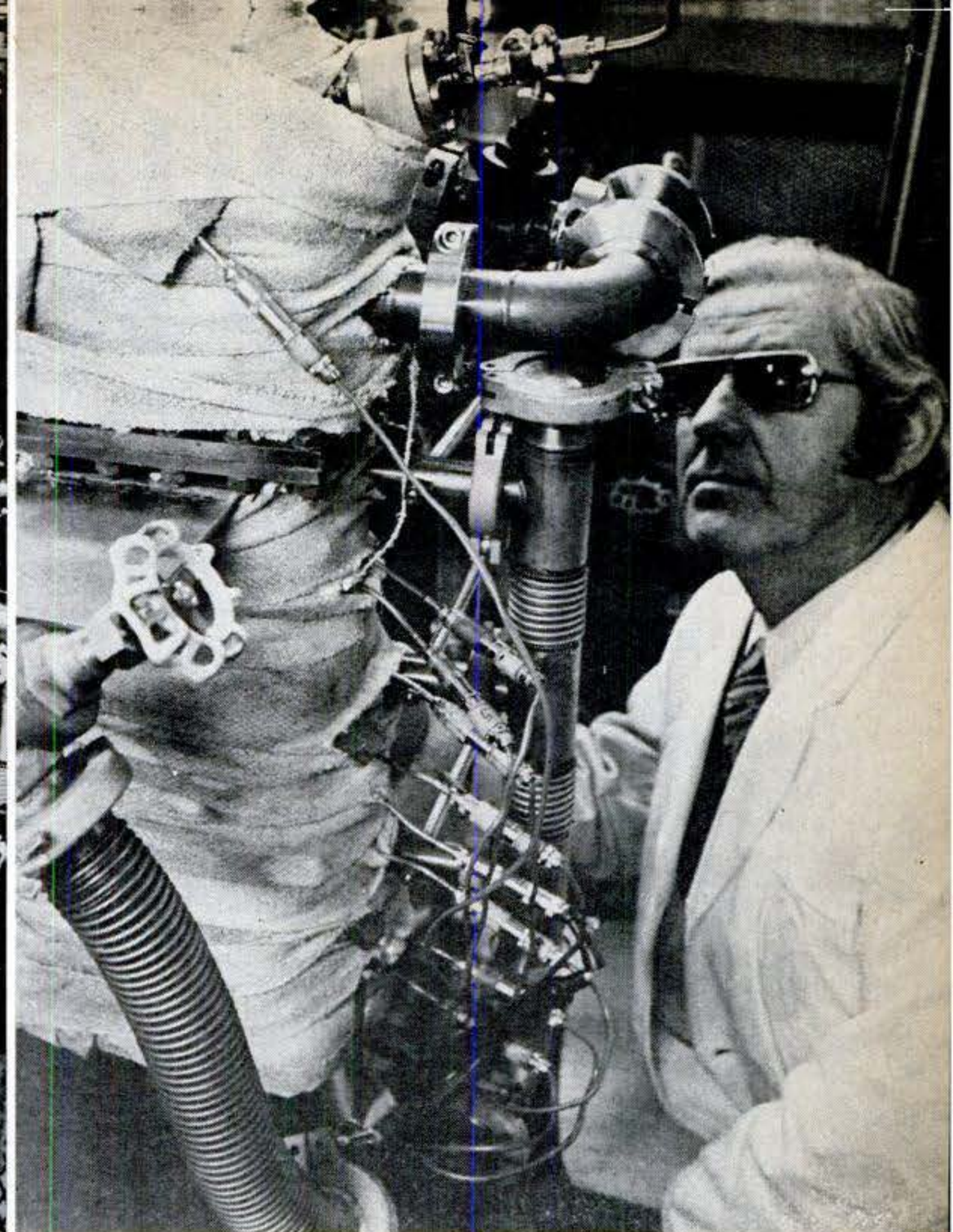
They quickly point out, however, that this loss can be restored by raising the compression ratio. The catalytically cracked fuel offers high knock resistance (high octane number) and is compatible with high-compression engines. The raw gasoline must be lead-free, as lead will contaminate the catalyst.

How effective? A series of tests has been made on a small auto engine that in conventional form emits 1.5-percent carbon monoxide and 1400 NO_x parts per million. By setting the standard carburetor for the leanest possible mixture consistent with drivability, CO emissions were cut to 0.5 percent and NO_x emissions to 1200 ppm.

In the first test with the Siemens carburetor the air/fuel mixture was



Siemens catalytic carburetor is tested on two-liter (122-cu.-in.) auto engine. Basic hardware and installation are simple, but test rig instrumentation is highly complicated.



For better heat insulation, catalytic carburetor installed on a larger 170-hp auto engine is entirely wrapped in asbestos. This carburetor is about 25 inches in height.

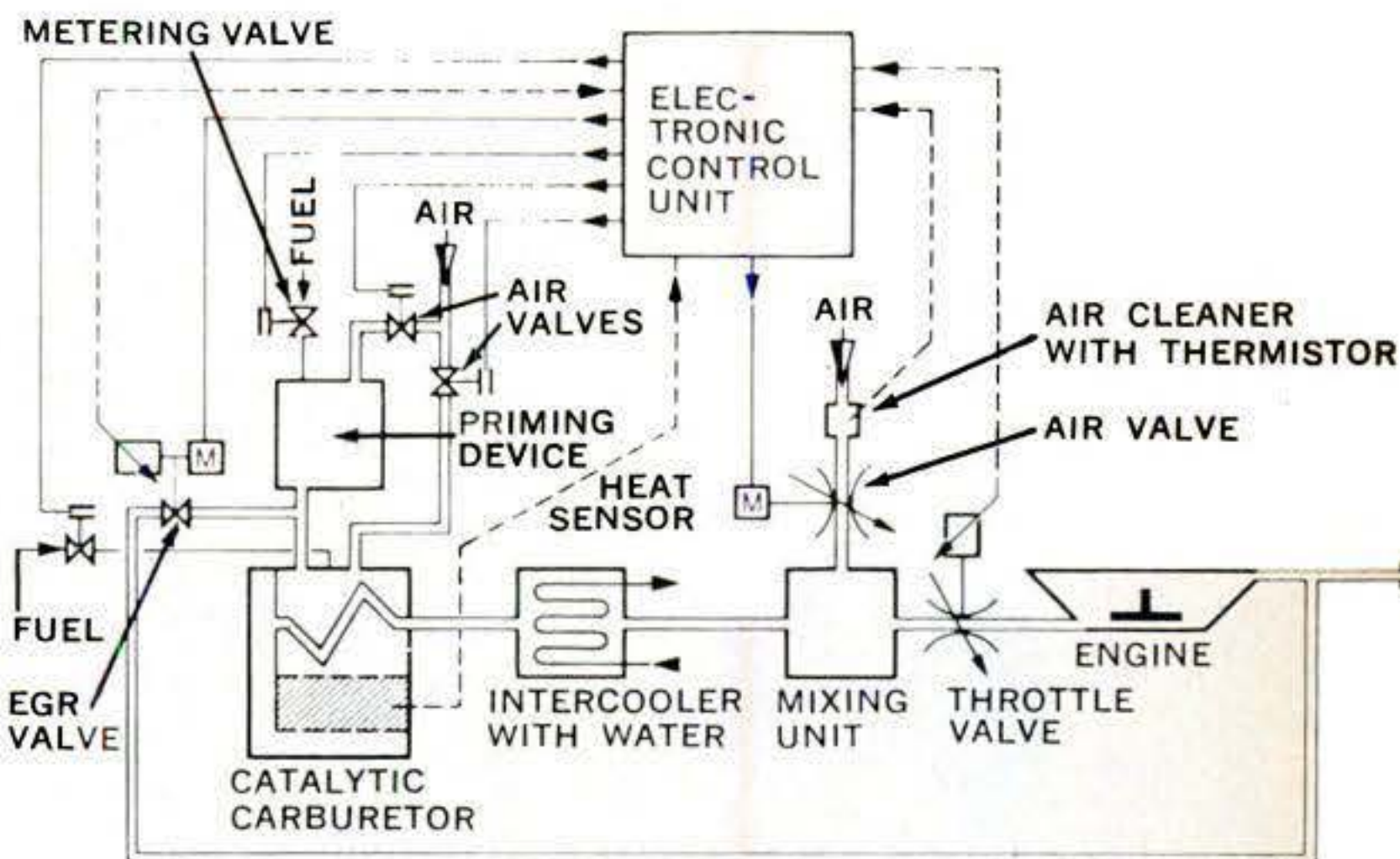
stoichiometric (ideal for combustion), which produced a 4.14-percent gain in power. CO emissions were 0.15 percent, and NO_x emissions 1000 ppm. Then the engineers progressively leaned out the mixture. With 20 percent more air (1.2 stoichiometric ratio) there was no power loss, and emissions had dropped to 0.09-percent CO and 40-ppm NO_x. And that's with about 20-percent better gas mileage, too.

Tests with still leaner mixtures were made, up to 1.25 and even 1.3 over stoichiometric. That lowered NO_x emissions further, but caused a rise in CO emissions, while there was a sizeable power loss (15 to 25 percent).

Vs. U.S. '76 standards? The NO_x limit of 0.4 g/mile corresponds to 25 ppm average exhaust concentrations. The 3.4 g/mile CO limit corresponds to 40 ppm. The lowest CO content achieved by Siemens was 60 ppm, or 50 percent too high. If you think that's disappointing, remember that this was merely a first test.

The engine itself was not optimized for clean air, and the fuel system was not designed specifically for the engine. It's likely that normal development work will bring the emission levels down below our '76 standards.

All functions in the Siemens fuel system are controlled by an electronic unit. Fuel is gasified before being mixed with air into a combustible charge. It's all gas, without fuel droplets, so mixture can be extremely lean. That means complete combustion and more mpg.



The Siemens engineers are confident it can be done.

In addition to cleaner exhaust and more miles per gallon, the Siemens carburetor promises a host of minor advantages from gaseous fuel:

- Easy cold-starting.
- Longer oil-change intervals.
- Quieter running.
- Reduced engine wear.
- Dilution of the lube oil by condensed fuel running down the cylinder wall is eliminated.

What about catalyst life? The Clean Air Act specifies 50,000 miles durability. Siemens engineers say

they do not expect any difficulty in meeting that requirement. The catalyst here is not subject to large amounts of hot exhaust gases, but to ambient air and fuel.

How about cost? GM President Edward N. Cole has put a price tag of \$275 on the 1976-model catalytic converter system (over and above the controls on '72-model cars, which had about \$100 worth of emission-control equipment). The Siemens catalytic carburetor will be a viable alternative as far as cost is concerned. Estimates range from \$200 to \$300 per unit.

EARTHQUAKES—

Now Science Can Predict

Within the last year, seismologists have figured out what happens underground before a quake, making the old dream of prediction come true. Even control is within sight.

By C. P. GILMORE

About midday on July 30, 1973, a team of seismologists from Lamont-Doherty Geological Observatory noticed a strange phenomenon. A network of portable seismographs emplaced around the Blue Mountain Lakes region in New York State's Adirondack Mountains indicated an abrupt change in the relationship of certain seismic waves passing through the underground rock. This ratio of wave velocities remained abnormally low until Thursday, Aug. 2, when it returned to normal.

It was the sign the team had been waiting for. "We called a few seismologists not connected with Lamont," recalled Dr. Lynn Sykes when I saw him about a week later, "and predicted an earthquake for the next day."

At 7:10 pm on Friday, August 3, a small, magnitude 2.5 earthquake gently shook the region as predicted.

Portable seismometer below is one of six that captured telltale ground tremors and led to the world's first pinpoint earthquake prediction. Geophysicist Yash P.

"I think," said Sykes, "that this is probably the first successful prediction of an earthquake in the U.S."

More than that, it opens a new era. The accomplishment—and the work leading up to it over the last several years in Russia, Japan, and the United States—promises to open the age of truly scientific earthquake prediction. Says Dr. Christopher Scholz, another member of the Lamont team, "Earthquake prediction, an old and elusive goal of seismologists and astrologers alike, appears to be on the verge of reality . . ."

The new technique is still beset with many difficulties—scientific, financial, and social. It may work for only one of the two major types of earthquakes. But much of the confused and contradictory picture surrounding the field has apparently cleared. And the prospects for not only predicting, but controlling,

Aggarwal of Lamont-Doherty Geological Observatory holds device that picks up broadcast time signals, puts calibration marks on drum.

earthquakes, are suddenly very bright.

It would be hard to think of a more important scientific development; earthquakes are among the most devastating of disasters. The San Fernando, Calif., quake of 1971 was a moderate event of magnitude 6.4. But it killed 64 and did a billion dollars worth of damage. Last year (1972) earthquakes killed more than 10,000 around the globe including 5000 in Iran, another 4000-6000 in Nicaragua.

What makes a quake? Earthquakes happen because the surface of the earth is in turmoil. Geophysicists now know that the oceans and land masses float about on huge plates, continent-sized slabs of rock that drift through the plastic inner mantle like so many ice floes on an Arctic sea. ["Plate Tectonics—A Startling New View of Our Turbulent Earth," PS, June '72.] Where the edges of these plates crunch together, the constant breaking of rock produces the tremors we call earthquakes. Quakes also happen along other breaks or faults in the rocks—faults that occur within the plates themselves from the stresses and strains that develop as the restless earth's cover attempts to adjust.

Earthquakes come in two basically different varieties. A strike-slip quake develops when two sides of a fault move in opposite directions. A thrust quake is generated where one crustal plate is being slowly jammed down beneath another. The two types are about equally common.

But while we pretty well understand the *why* of earthquakes, we've been mystified about the *when*. Everyone knows that the plates on either side of California's famed San Andreas fault slip an average of 3.2 centimeters per year, that in some areas they've been locked for years, and that sooner or later they'll let go with a roar. When it happened in 1906 the opposite sides jumped 20 feet and generated shock waves that destroyed San Francisco and killed 700. But will it happen again this year—or 50 years from now?

From average fault movement, Dr. Robert Wallace of the National Center for Earthquake Research in Menlo Park, Calif., estimates that a magnitude 8 earthquake (about the size of the 1906 San Francisco quake)

Continued



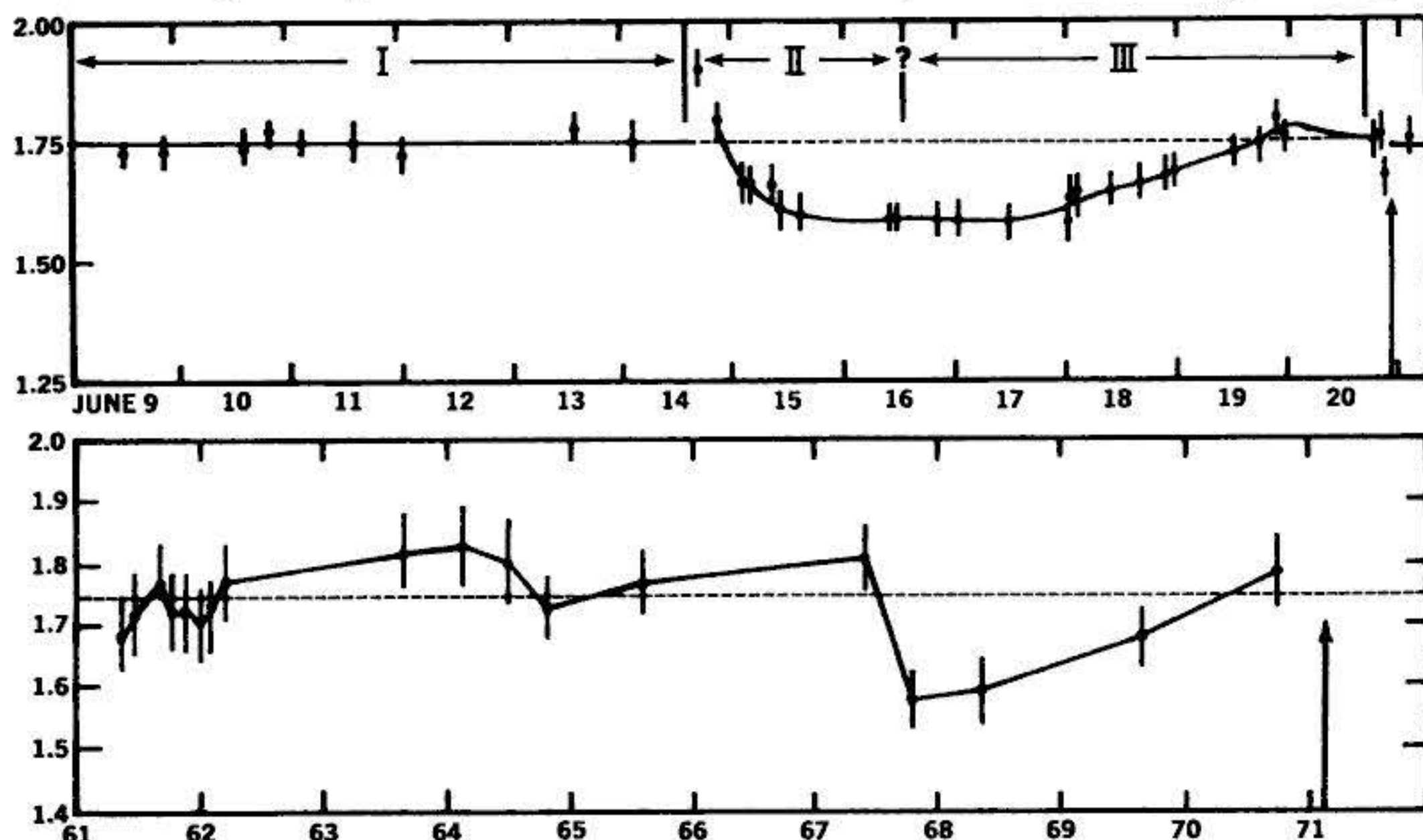
When and Where They'll Happen

Seismic signals predicting the catastrophic San Fernando earthquake of 1971 were on seismographic records—had we

but known how to read them. Recent research has shown scientists that specific signals could help predict such events.

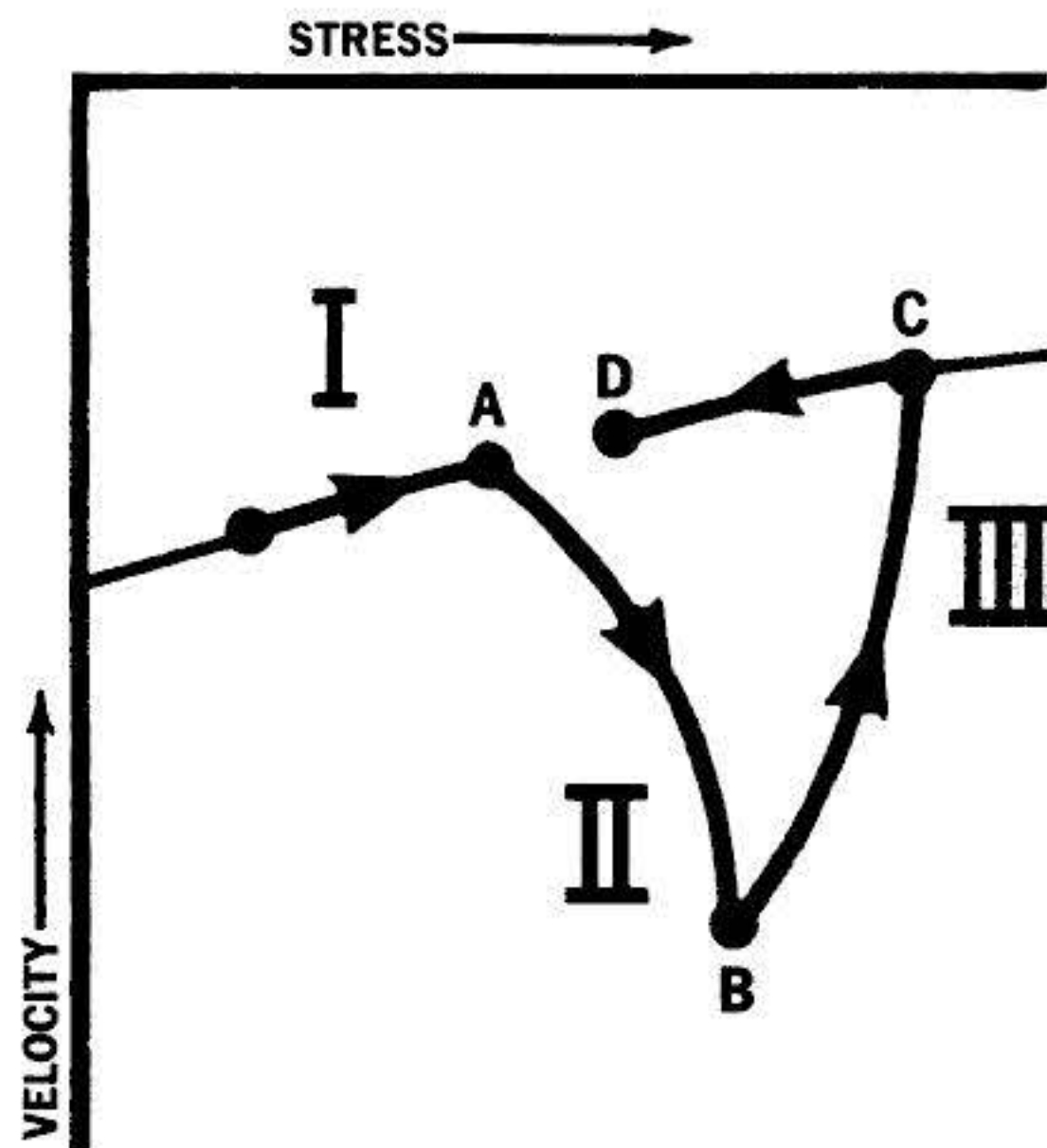


"It may be possible to control quakes along dangerous faults"



Key to earthquake prediction may be in the curves above, which demonstrate a phenomenon called dilatancy. Diagram at right shows how it works. As stress in rock builds (Stage I), velocity of one type of seismic wave (P wave) increases slightly as dilatancy begins (A), small cracks form in rock, and velocity of P waves decreases sharply to B. Simultaneously, rock undergoes process called dilatancy hardening, which delays coming quake. At B, water enters cracks, raising the P-wave velocity (III). At C, velocity is normal again. Filling continues until D, when pores are filled, dilatancy hardening dis-

appears, and rocks break, causing earthquake. The effect is important because changing velocity can be measured and time of earthquake predicted. The two curves at top left show actual measurements of the ratio of P-wave to S-wave velocity (a slightly more accurate indicator), first preceding a small (magnitude 3.1) earthquake in New York State on June 20, 1971, next leading up to the killer San Fernando earthquake (magnitude 6.4) of Feb. 9, 1971. Dilatancy in the latter disturbance began in 1967, lasted 3½ years. Roman numerals refer to dilatancy stages in curve shown at right.



Dilatancy ties together many formerly mysterious warning signs. Top curve (below) shows velocity ratio, which varies as explained above. Dilatancy explains why electrical resistivity drops, then returns to normal. Radon, a radioactive gas, increases in well water; the surface of the earth in the quake area may rise a few centimeters—a frequently measured phenomenon; and microearthquakes, after first increasing as stress builds, decrease as dilatancy hardening takes place. Numerals refer to stages shown above.

will happen about once every 100 years. But that doesn't help much in knowing when to turn off the gas and get the kids out of school.

For years, earth scientists have been looking for earthquake precursors—warning signs that could be used to forecast the arrival time of an earthquake. ["Can We Stop Earthquakes from Happening?" PS, Apr. '69.] The Japanese, in fact, have had an official earthquake-prediction program for almost a decade. And they've found some. Careful geodetic measurements, for example, have shown that some earthquake-prone areas are slowly uplifted several centimeters per year. From 1965 to 1967, Japanese geophysicists measured earth tilt and uplift, the intensity and number of microearthquakes, and changes in the strength of the earth's magnetic field in the Matsushiro region. On the basis of these measurements they issued warnings on several occasions that earthquakes were likely to happen in coming months.

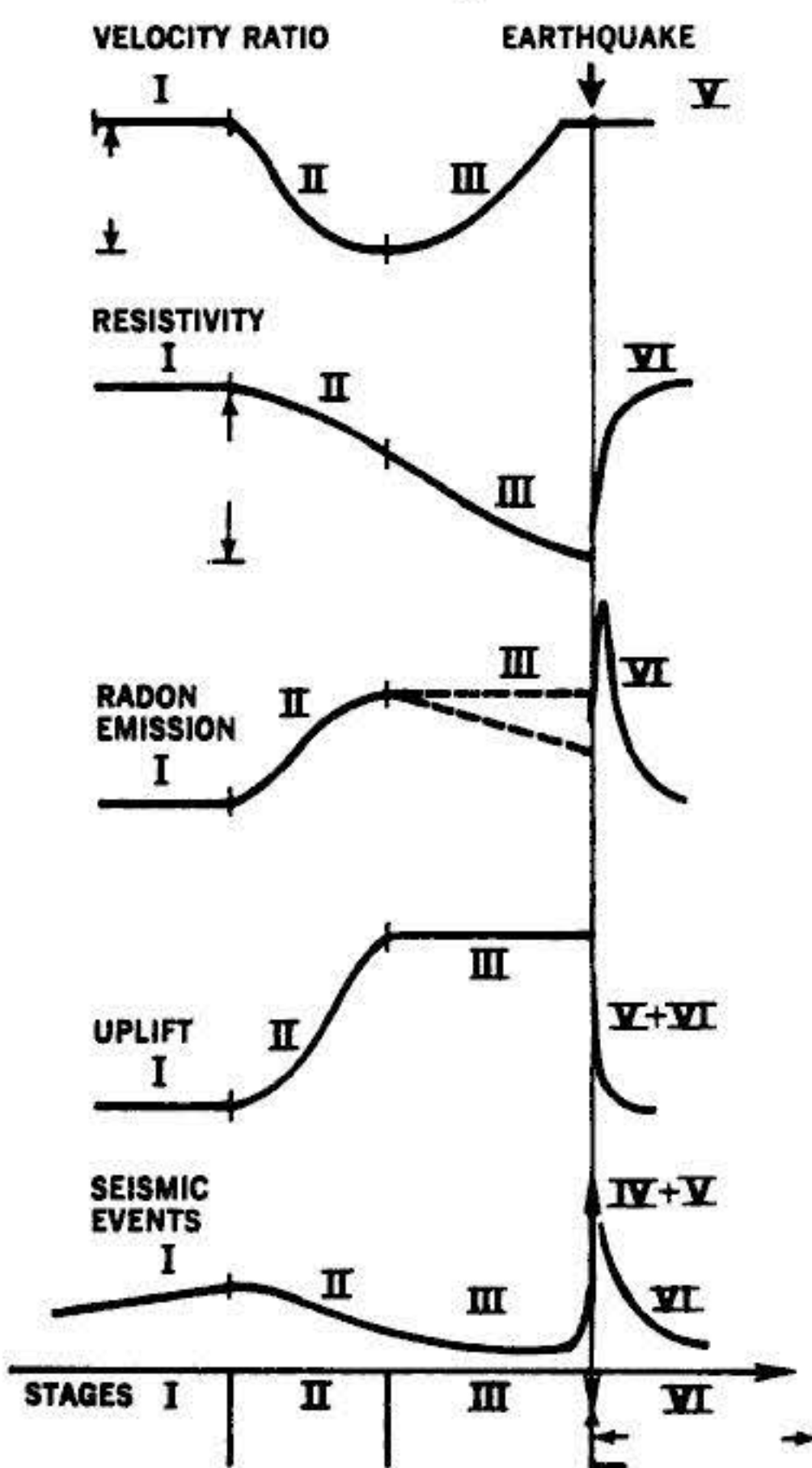
The Russian effort. They have been working on prediction, too. They've discovered that the electrical resistivity of the earth seemed to change before some earthquakes, and used this to successfully predict an earthquake in the Kamchatka region on the Bering coast in the mid 1960's.

The Russians also found that a strange thing sometimes happens to

well water before an earthquake. Most rocks contain small amounts of a radioactive element called thorium. As ground water comes in contact with the thorium in rocks, a small amount of a radioactive gas called radon is created. By looking at continuously kept records, they discovered that the radon count had gone up several weeks before two quakes in the Tashkent region.

In the U.S., too, the search for precursors went on. Earth scientists scrambled all over active faults installing tiltmeters, seismographs, and other instruments in an attempt to detect some pattern of events that would lead to earthquake prediction. A few predictions were even tried. In March of this year, for example, Robert Wesson and William Ellsworth of the NCER found that a number of quakes had occurred at relatively even intervals along one section of the San Andreas fault near Hollister, Calif. But none had occurred along one section of the fault. So they predicted that a quake would occur in this "seismic gap" within a few months.

The problem with all of this work was that nobody knew what he was looking for. "We just set out to measure everything under the sun and hoped to find something that occurred before earthquakes," said Dr. Scholz. But nobody had any real idea *why* all of the various precursors were happening. Or why they



seemed to be there sometimes and not at others. Or how to use them for anything like an earthquake-prediction system. Needed obviously was not more blind searching, but some unifying theory—some understanding of what was happening underground and why.

First glimmer of hope. Though no one recognized it at the time, it came when a Russian seismologist named A. N. Semenov made an odd discovery. Monitoring the seismic waves generated by earthquakes in the Garm region of central Asia, he detected a series of strange events.

Seismologists have known for decades that earthquakes release energy in two basic types of seismic waves:

- **P waves** (primary or compression waves) move through the earth like sound waves; the earth particles vibrate back and forth along the direction the wave is traveling. P waves move fast—about 3.75 miles per second. They are first to hit a seismograph and signal the occurrence of an earthquake.

- **S waves** (secondary or shear waves) vibrate from side to side like the wave motion that travels down a suspended rope when you shake one end. S waves travel slower than P waves—about 2.2 miles per second. The ratio of P-wave to S-wave velocity—the number turns out to be critical in prediction—is about 1.75.

What Semenov discovered was that the P- to S-wave velocity ratio, instead of remaining constant at 1.75, dropped suddenly some weeks or months before a quake. Then it suddenly returned to normal. A short time later, the quake struck.

About two years ago, Dr. Sykes of Lamont went to Russia and learned of the unusual discovery—what scientists now call the velocity anomaly. At the same time, Sykes and two other Lamont scientists, Yash Aggarwal and J. Armbruster, were studying a swarm of small earthquakes then taking place at Blue Mountain Lake in New York's Adirondack Mountains. They began looking for the velocity anomaly spotted by the Russians at Garm—and found it preceding several moderate quakes.

This was exciting news. The problem with the other precursors—the uplifts, changes in electrical resistivity, magnetic shifts, and so on—was that they fit no coherent pattern. The velocity anomaly, on the other hand, promised to be the key.

Seismologists have long pursued their science in two ways. First, they measure seismic waves traveling through the earth. Second, they measure the same kinds of waves travel-



Big question is whether dilatancy that apparently works on thrust-fault earthquakes can help predict strike-slip

quakes, which happen on parts of California's San Andreas fault, shown here just south of San Francisco.

ing through rock samples in a laboratory under controlled conditions.

One of the centers of this rock-mechanics work is the MIT laboratory of Dr. William Brace. Brace and his assistants had made many painstaking studies on the properties of rocks under widely varying conditions that might be found deep in the Earth.

During the 1960's, Brace worked with two graduate students named Chris Scholz and Amos Nur. And both were strongly aware of a peculiar property of rocks discovered in the laboratory—a peculiar phenomenon called dilatancy. When a rock sample is subjected to enough pressure, it breaks. But shortly before it breaks, it becomes dilatant. A network of small cracks spreads through the rock, and it expands slightly as a result. If the pressure

continues to build up, it fractures.

Nur made an important observation. He measured P- and S-wave velocity and how they varied with pressure in both wet and dry rock. He found that as stress went up, P waves tended to travel slightly faster, and that velocity was considerably higher in wet or saturated rock than in dry.

The picture comes clear. As word of the Russian velocity anomaly discovery and its confirmation at Blue Mountain Lake began to seep through the seismological community, two teams—one at Lamont where Scholz now worked, the other at Stanford where Nur had located—simultaneously, independently began to put the whole picture together.

Although details varied and some of the elements have since been added, the explanation they worked out

[\[Continued on page 140\]](#)

World's first successful earthquake control experiment actually turned quakes

on and off in this bleak valley in northwest Colorado, near Rangely.



Now Playing: The PS 4-Channel Test



Amid microphones, instrumentalists and singers, Enoch Light conducts musical passages of test record. Above, he briefs Hawkins on 16-channel recording process. The 16 will be mixed down to four channels (below).

Here's your key to choosing—and using—quadraphonic sound

By **WILLIAM J. HAWKINS**
PS Electronics Editor
PHOTOS BY ORLANDO GUERRA

Skeptical about four-channel sound? You probably haven't heard real four-channel material on a properly set-up system. Our new test record will help on both counts. You can check out and align your equipment with the technical tests on side one; flip it and the other side gives you specially recorded music specifically designed to demonstrate true four-channel sound.

You'll hear the Quad Guitars enter a song individually—from four directions—then pass it from one speaker to the next. You'll actually be among the musicians as four areas of the vocal group come alive with you in the center. And, contrasting instruments will demonstrate the overall four-channel effect as each comes from four separate locations of your listening area.

On the other side, you'll have all the technical tests and procedures you need to tune your system to



Final mix puts together technical and musical cuts and narration. Entire track

is then recorded on SQ and CD-4 discs, and 8-track and open-reel tape.

Record



peak performance—and keep it that way. The tests are of the same high quality as our '68 Stereo Test Record (still available, and since become a standard for set manufacturers as a production-line test disc).

This quadrasonic test record is the first of its kind. You can get it in the popular Columbia SQ version or the discrete JVC-RCA CD-4 Quadradisc version; on reel-to-reel tape or eight-track cartridge.

If you already own a four-channel system, you'll use the record to check out frequency response, alignment, and balance—all necessary for getting the best performance from your equipment. Other tests check system wiring and the playing-room qualities.

If you're just starting a quadrasonic system, take the record along when you shop. Undecided whether to buy SQ or CD-4? Get both records (a double bargain) and hear the same material on both types of rig. Here's what these records contain:

- *Speaker-location and phasing test.* Miswired or improperly marked input or output leads can put wrong or out-of-phase signals into one or more speakers. A series of tones help you check (and correct) both.

- *Balance.* This level-set test allows you to find the right quad balance of volume and tone for your particular system and listening point.

- *Wow and flutter.* This steady tone will point up any unsteadiness in the drive mechanism of your rig.

- *Frequency response.* Similar frequency-response characteristics on all channels is important in four-channel reproduction. A special "pink noise" test makes adjustment easy.

- *Room resonance.* Subtle noises or irritating sounds can be sympathetic vibration from lamps, furniture, windows, or walls. This sweep-tone test helps pinpoint the source.

- *High-frequency response.* A sharp, percussive sound of bells helps you check for proper high-frequency tracking of your turntable cartridge.

- *Bass and transient response.* Good bass and transient response are just as important as high-frequency performance. Carefully chosen and specially played instruments aid you in evaluating them.

- *Additional help.* If you do find problems with your rig, helpful hints in the record jacket tell you how to track down and correct them.

Enoch Light, who produced the record, is one of the country's au-

thorities on making four-channel records. His recordings are widely used as test and demonstration material by leading equipment manufacturers and even by other record makers.

On the instrumental side are selections by famed Tony Mottola and the Quad Guitars, The Brass Menagerie, The Nashville Jets, and, of course, Enoch Light and The Light Brigade. PS

Use this order blank to get your 1974 test record or tape

Check off the appropriate box for the selection you want. Send with check or money order (no cash please) to PS Test Record, Project 3 Records, 1133 Avenue of the Americas, NYC 10036. List prices are shown, but order now for the special introductory offer:

- ☐ SQ—regularly \$5.98, now \$4.98
- ☐ CD-4—regularly \$5.98, now \$4.98
- ☐ Both SQ and CD-4—\$11.96, now \$8.00
- ☐ 8-track cartridge—\$7.95, now \$6.45
- ☐ Reel-to-reel tape—\$11.95, now \$9.95
- ☐ Stereo test disc—\$5.98, now \$4.98

Name

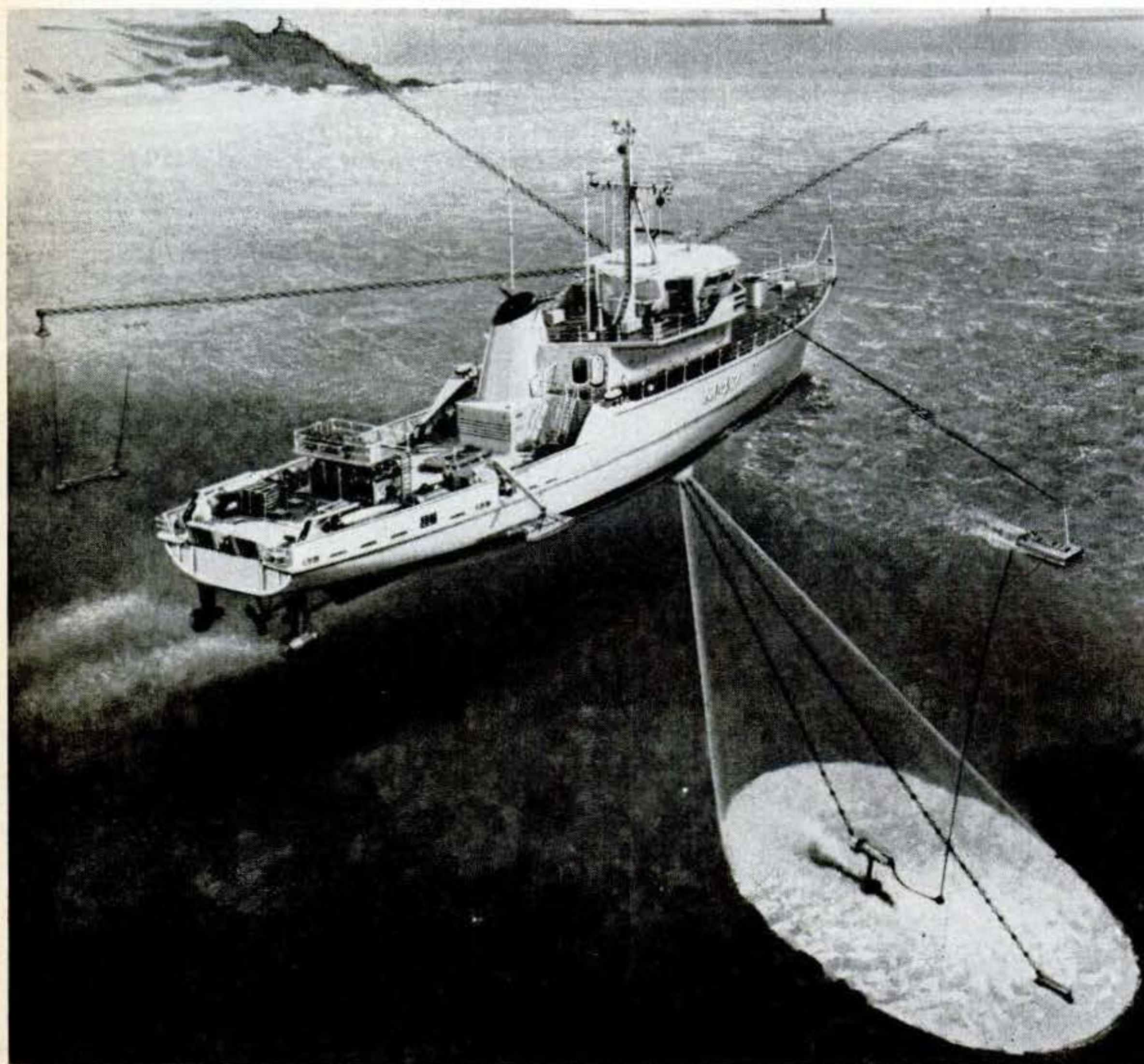
Address

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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

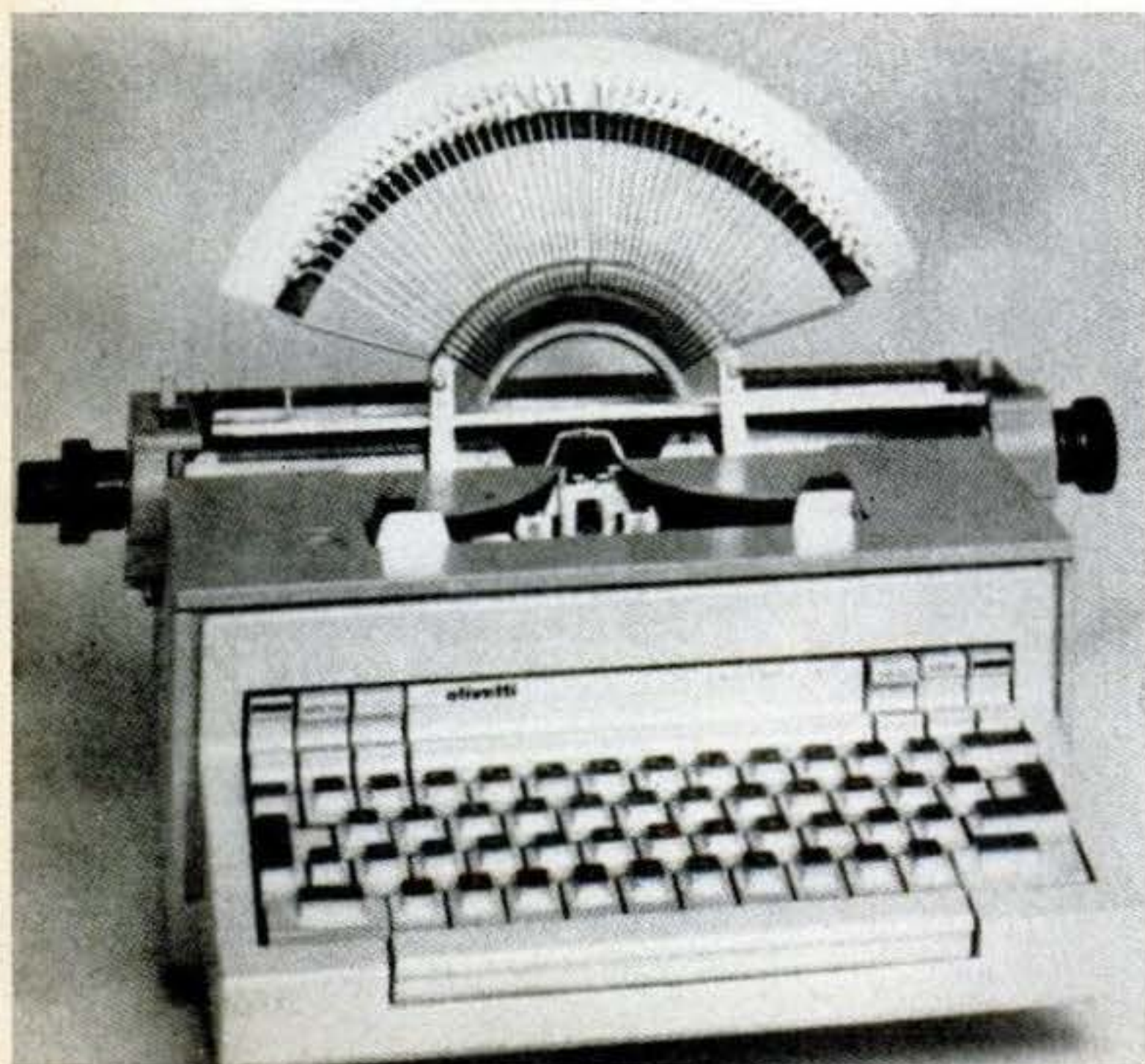


Ground bug

"Bug" the ground to detect intruders? Westinghouse has developed a sensor—essentially a microphone up to 1000 feet long—for the job. A narrow metal tube with insulated wire threaded through it is buried. Since wire and tube form a capacitor, nearby footsteps generate a voltage to trigger an alarm.

Mine hunter

This British mine hunter will use an unmanned, radio-controlled catamaran towing an underwater destruct weapon. The weapon is directed to the mine by sonar contacts with both, while the cat transmits underwater TV views. The Vosper Thorneycroft ship will plot its position using beacons and buoys.

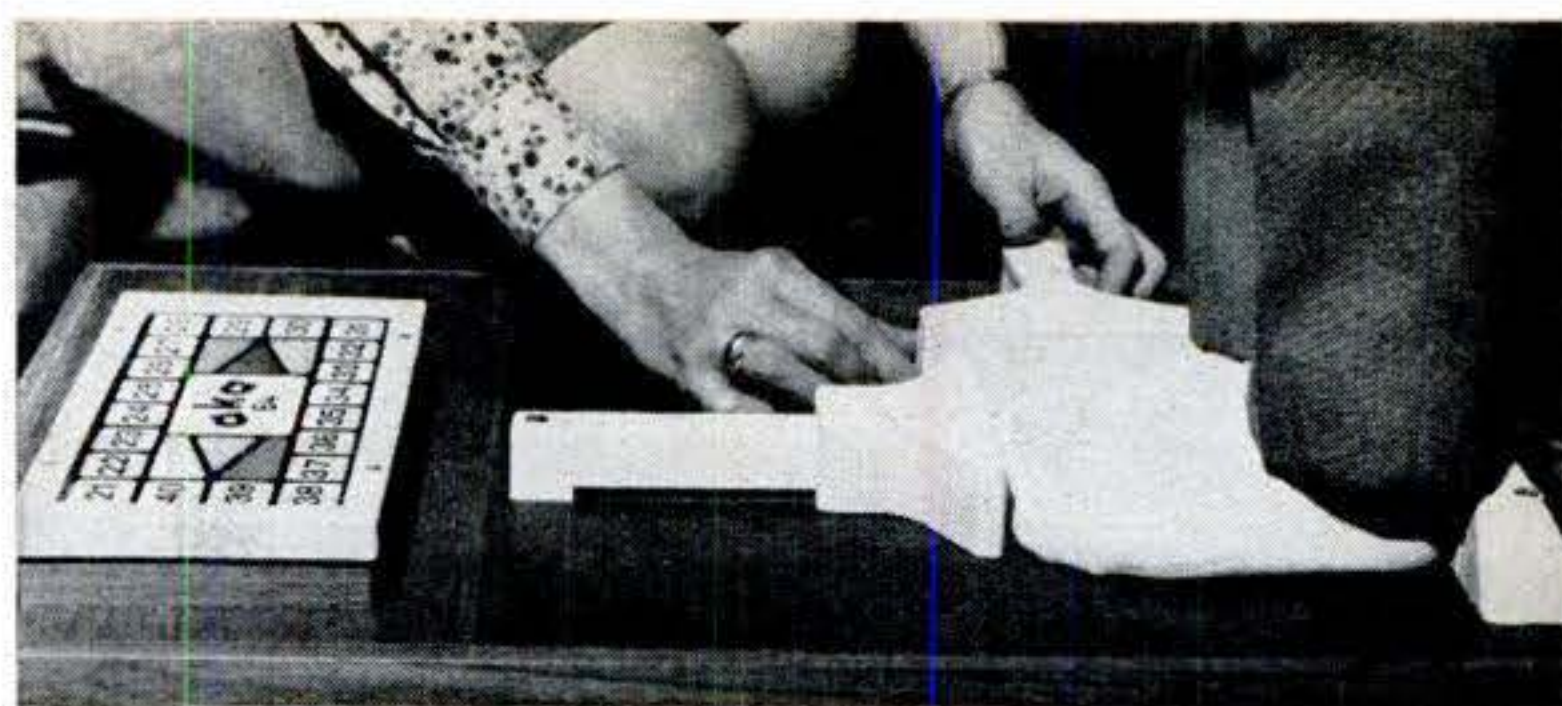
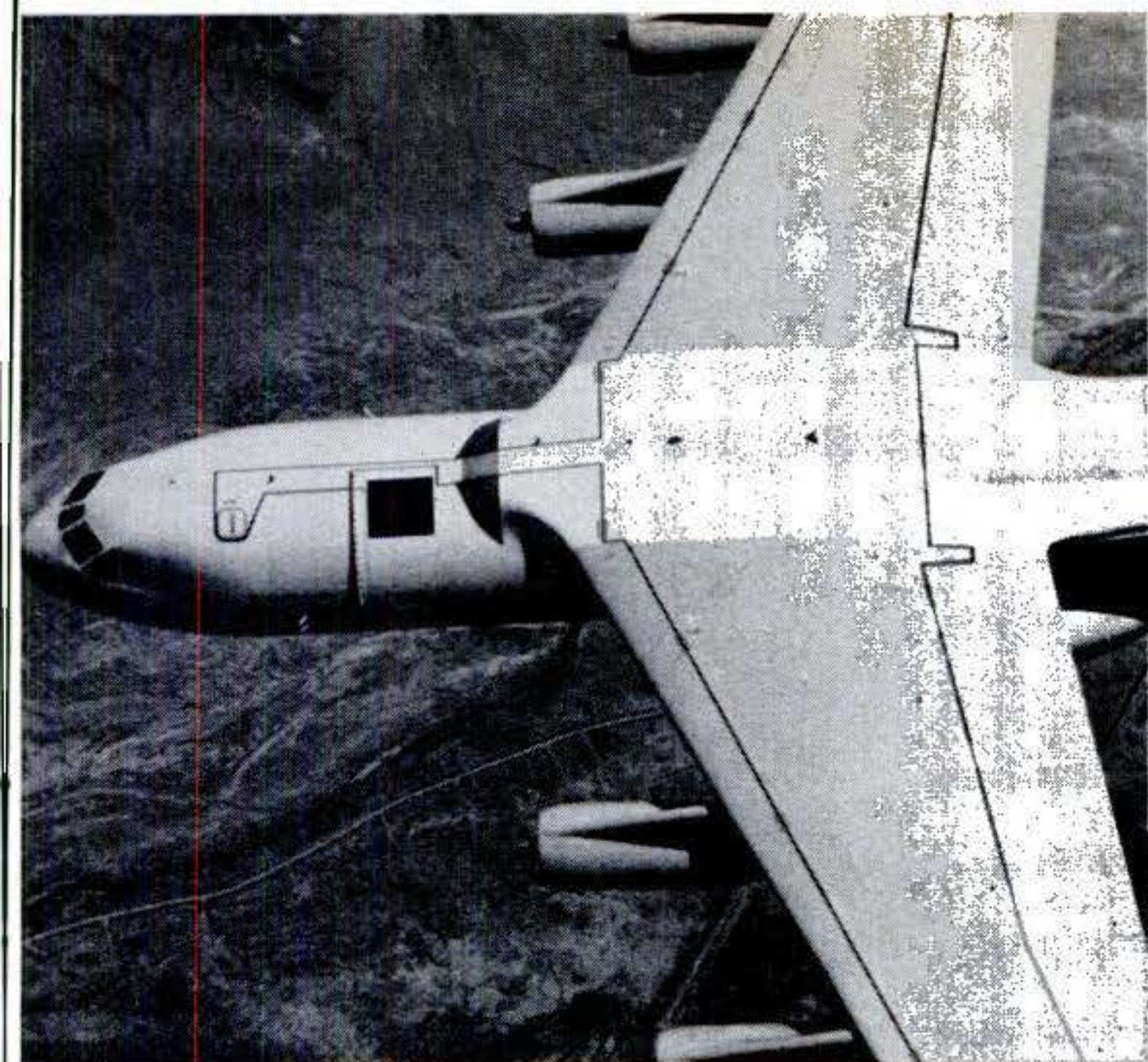


Character fan

Typing some hairy math or chemical formulas? That fan-shaped gadget—AWT's Typol 174—makes the typing easy. Added to Olivetti's Praxis 48 electric, it turns the 88-character machine into a 174-character unit. \$595, complete. AWT Co., 25B Post Ave., Westbury, N.Y. 11590.

Fuel saver

Storing its own braking energy, this vehicle from W. Germany's M.A.N. uses it to boost acceleration and cut fuel consumption. Friction brakes are aided by a hydraulic pump that charges a pressurized oil accumulator during braking. The pump assists the engine's drive. Fuel saving: 25 percent.

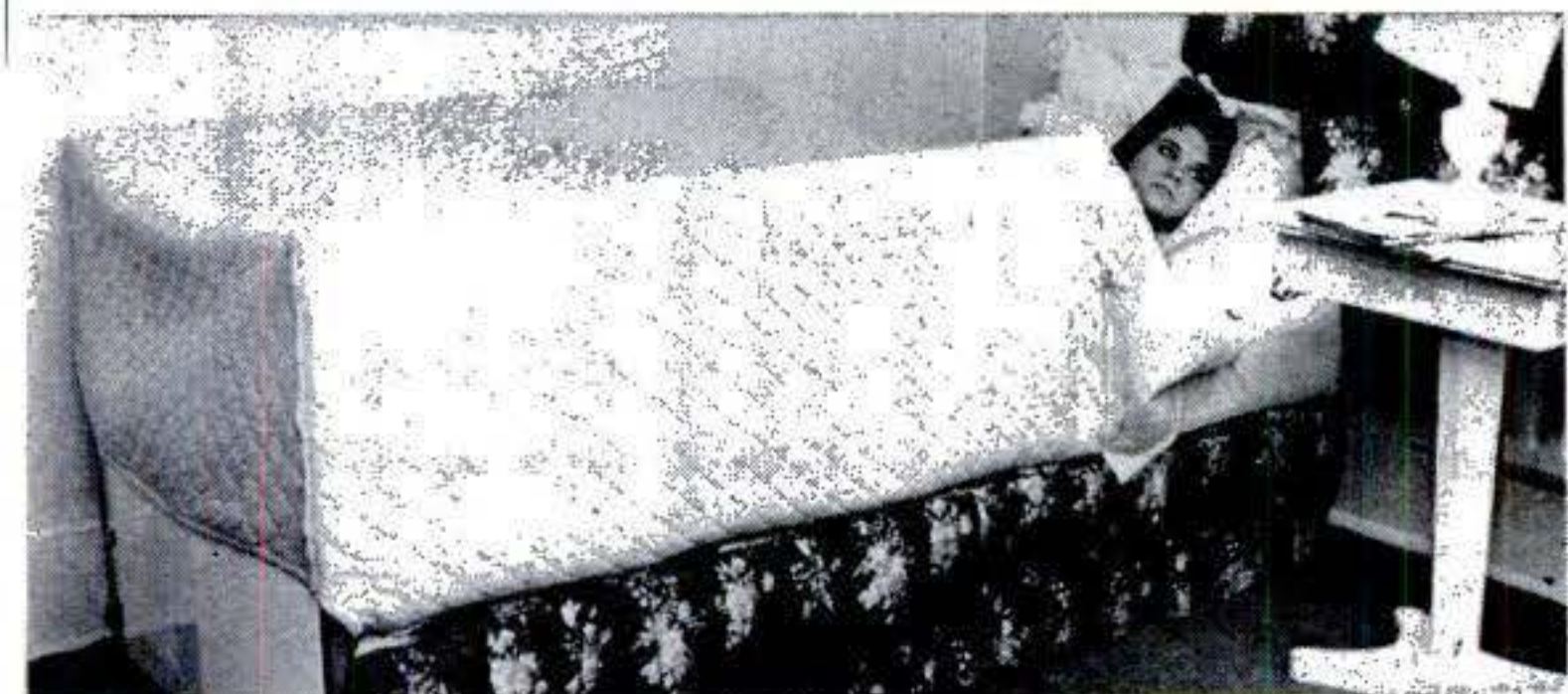


Infrared platform

NASA performed some surgical magic with Lockheed's StarLifter transport. Now it's a high-flying infrared observatory. Control and hydraulic lines were shifted and bulkheads installed to permit telescope observation through an open port on top.

Foot scale

A foot scale with a built-in electronic computer? This West German device coordinates children's foot size with their weight for the best shoe fit. Kids lean, bend, and crouch on the scale while it sums up foot-size changes. An index number then lights up.



Bed heater

Central heating for beds? That's what this British appliance provides. Telescopic arms hold the cover up, while a thermostat-controlled heater and fan maintain the temperature to an accuracy of two degrees. Range: 60-105 degrees F. For cooling, only the fan is operated. The system has various medical applications.



Inventory recorder

Can't find what you need on store shelves? That portable computer terminal above may soon help. With the Dart 8000, stores can update inventories fast. Data is stored on cassette tape, using a calculator-like keyboard, then transferred by phone to a central computer. Space Control, Stamford, Conn., makes it.

Two video-disc players for TV

Philips' new video-disc player—set for '75 production—uses 12-inch discs to pipe 45 minutes of color or monochrome viewing into any TV set (top). Transparent discs have a reflective metal backing pressed with a spiral track of microscopic pits. A photodiode converts a laser beam reflected from the track into TV signals. Teldec's improved video-disc player (bottom) will go on sale next month in Europe. Eight-inch, paper-thin discs play for 10 minutes with automatic loading and ejection. Discs have 7000 grooves per inch; a stylus converts bumps in the grooves into an electronic signal.



GM rotary

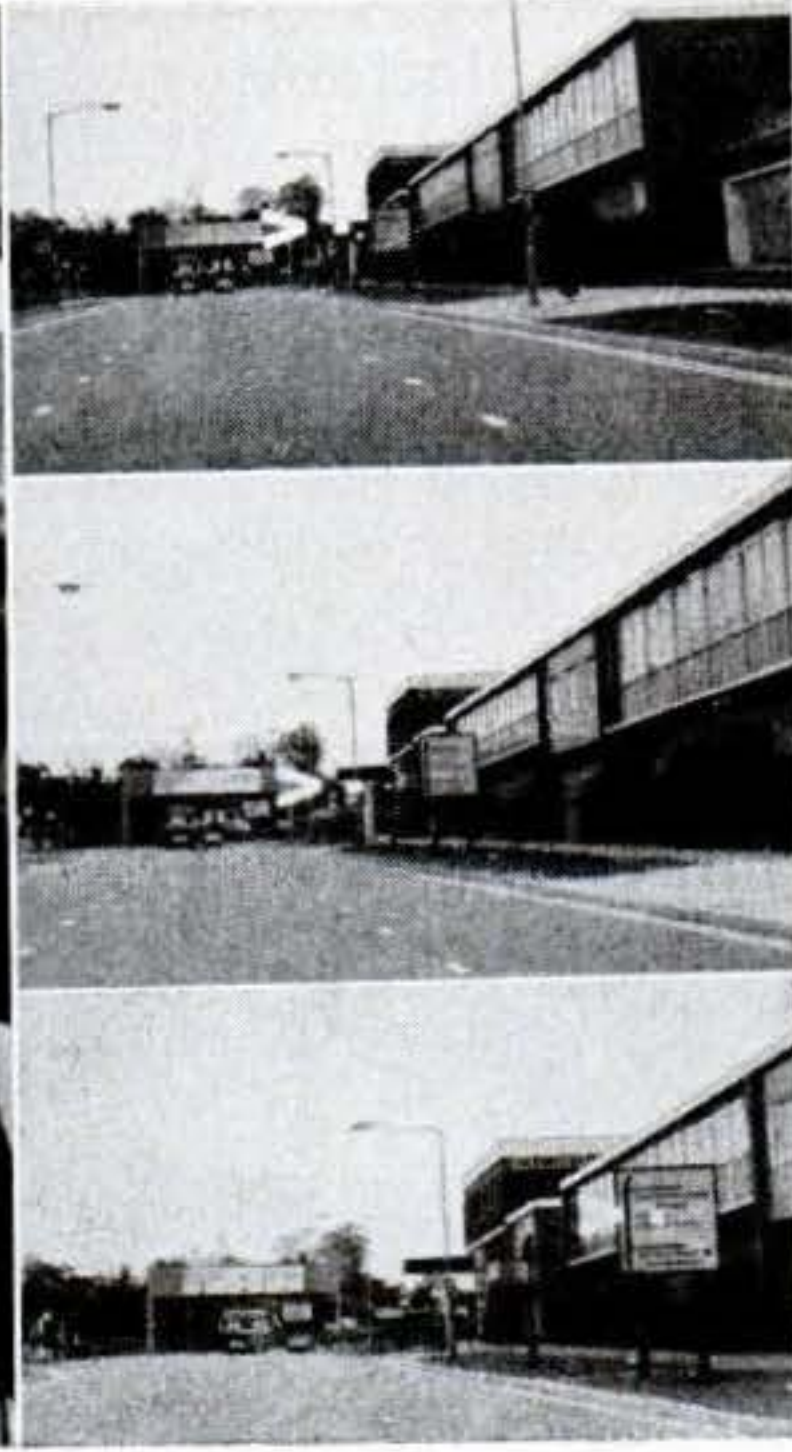
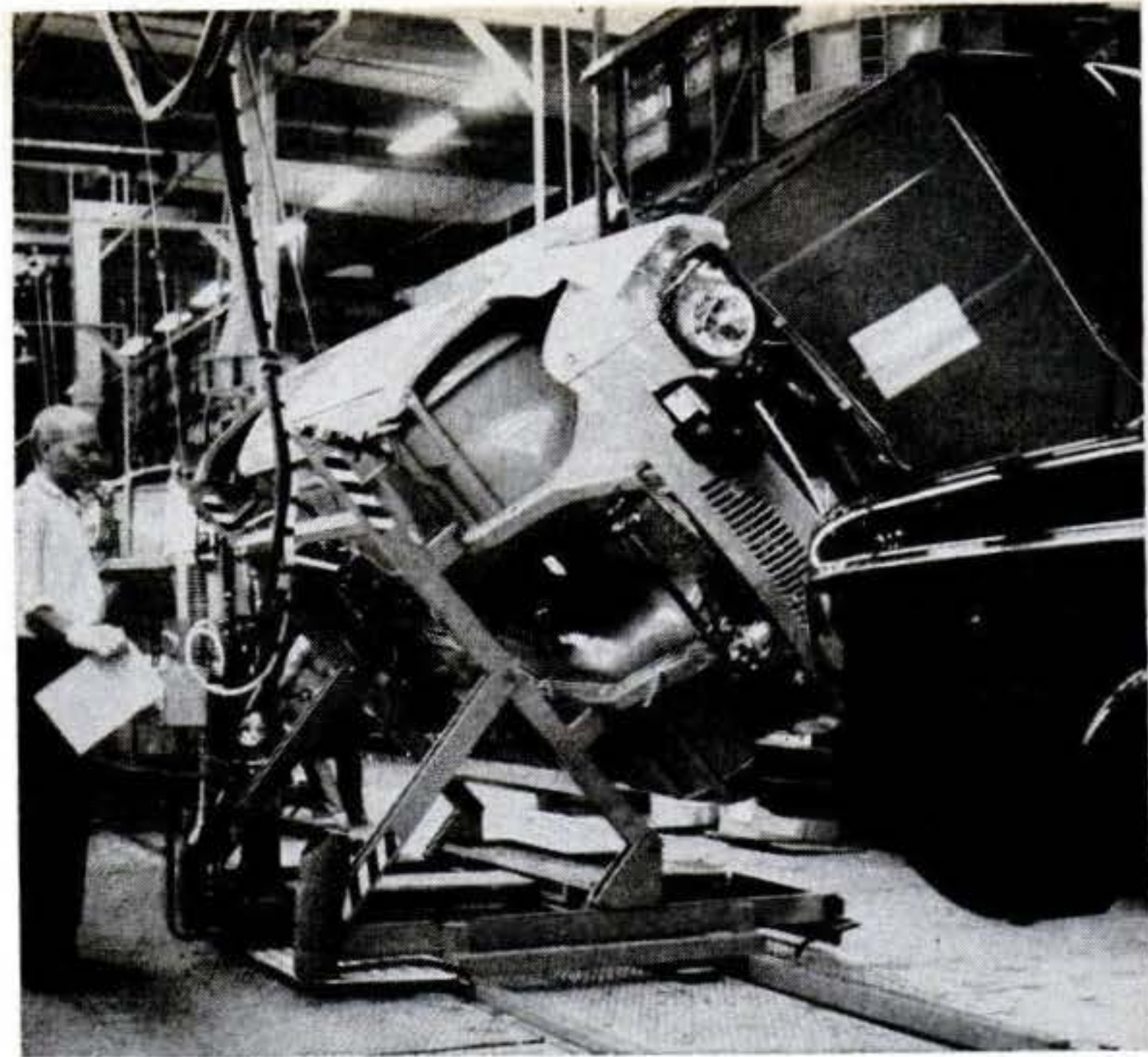
A new Corvette-type show car from GM has a two-rotor, 266-cu.-in. rotary engine mounted amidships. But don't look for it in showrooms—GM says it, and a larger four-rotor model, aren't slated for production. This version has McPherson struts for the rear. Horsepower is about 250.



What's New

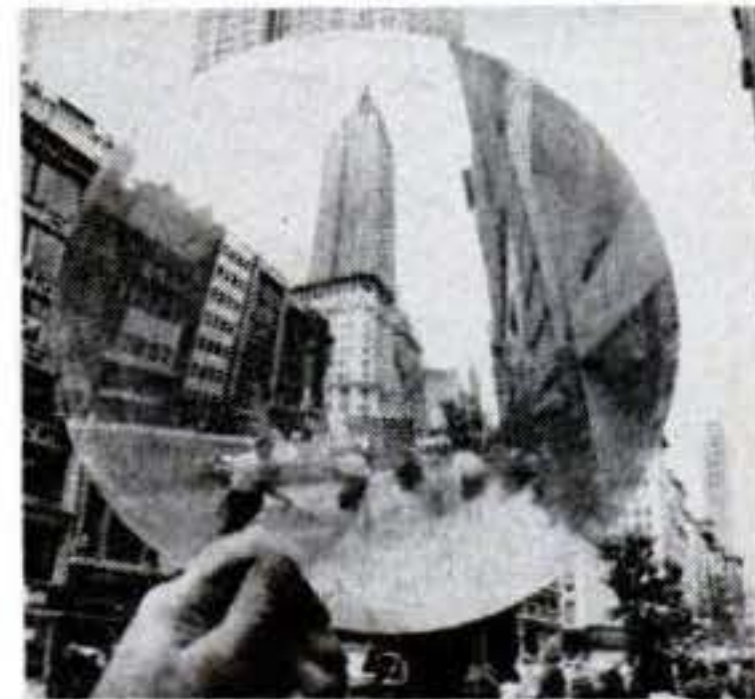
Tipper trolley

Workers in Volvo's new Chesapeake, Va., plant won't have to stand in a pit to place exhaust systems and fuel tanks. A tipper trolley on the assembly line will put the cars in handy position for workers standing alongside. The idea stemmed from a suggestion by Volvo's workers in Sweden.



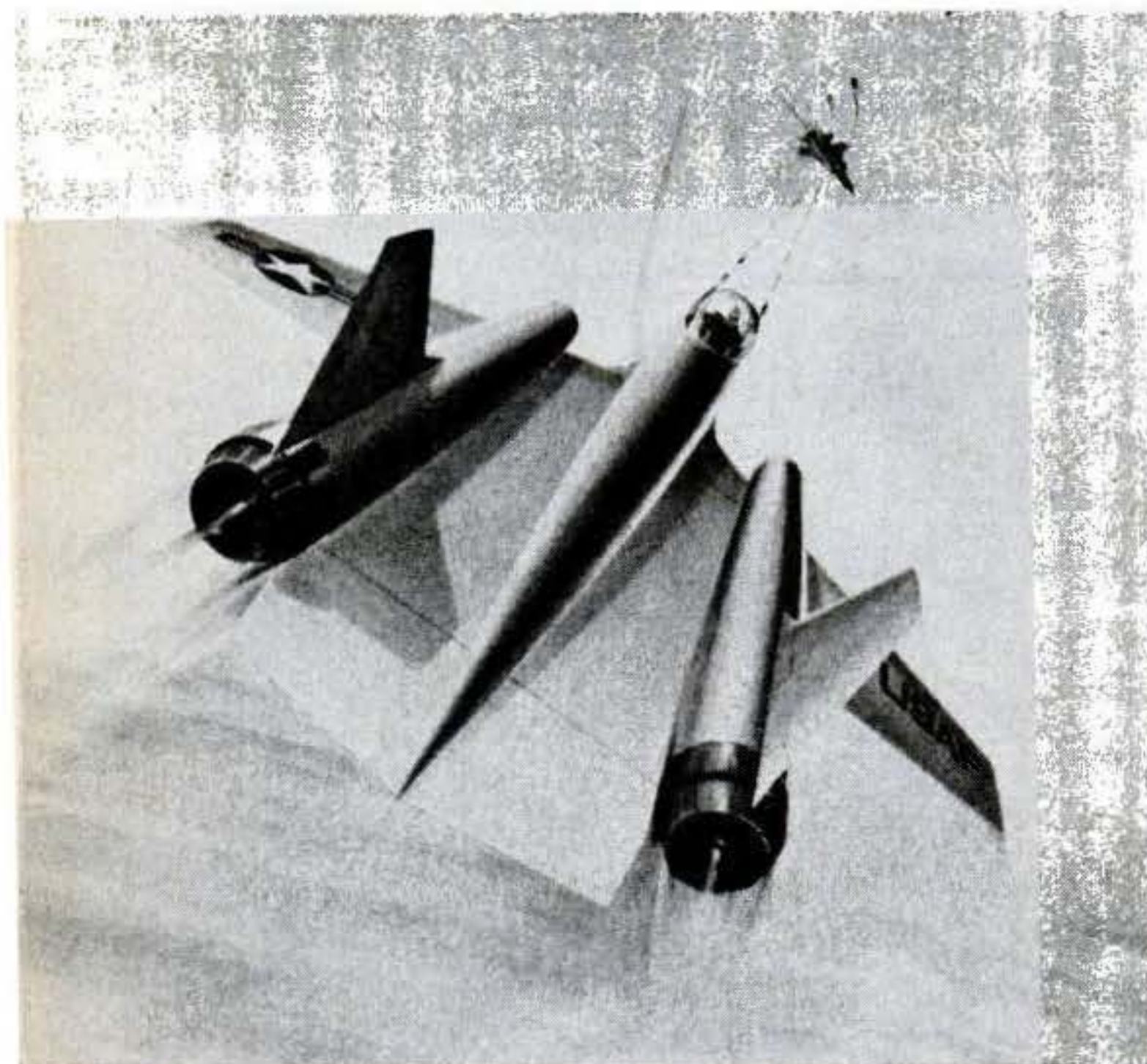
Eye tracker

What do you look at when you drive? That pretty girl on the corner? Or the road? English scientists have developed a machine that keeps an eye on your eyes and indicates their point of focus via a dot recorded on film and video tape. Light beams, fiber optics, mirrors do the tracking.



Flying testbed

Best way to check out new ideas in fighter design is to try them out in the air. This McDonnell Douglas "demonstrator" aircraft is proposed for that job. The craft would test concepts like vectored thrust, jet flaps, direct lift, and direct side-force control.

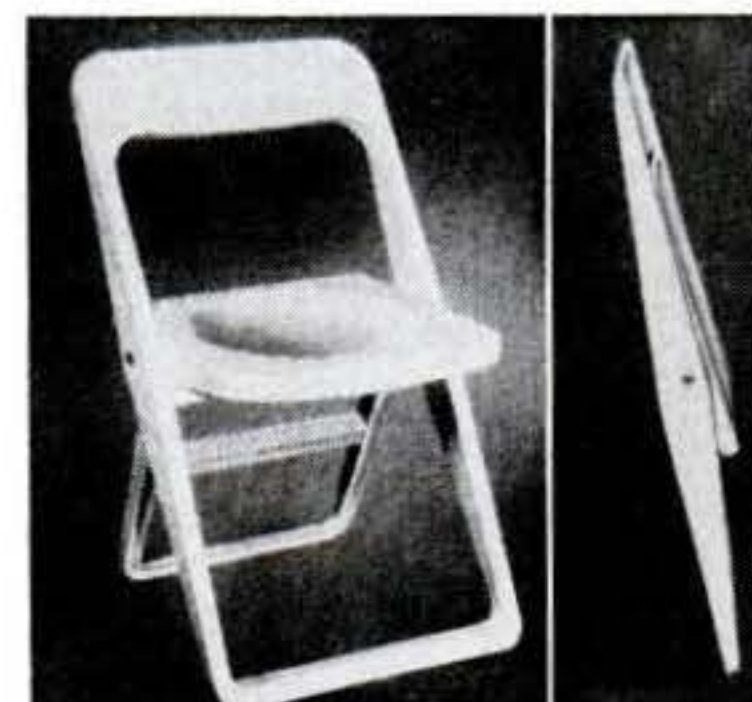


Flat fisheye

From Japan comes this 10 1/2-inch plastic fresnel lens offering a wide-eyed view of the world from one side, a fisheye view from the other. Great way to cut the Empire State Building down to size. Universal Specialties, 15 E. 40th St., New York, N.Y., imports and distributes it.

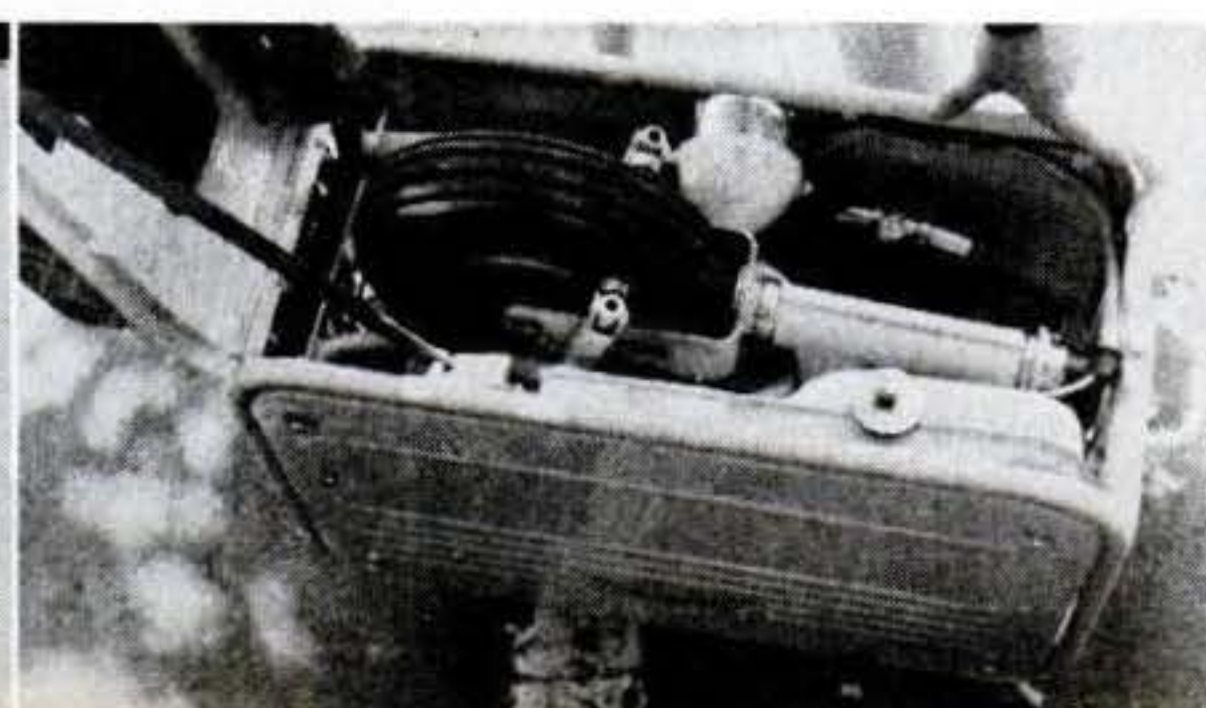
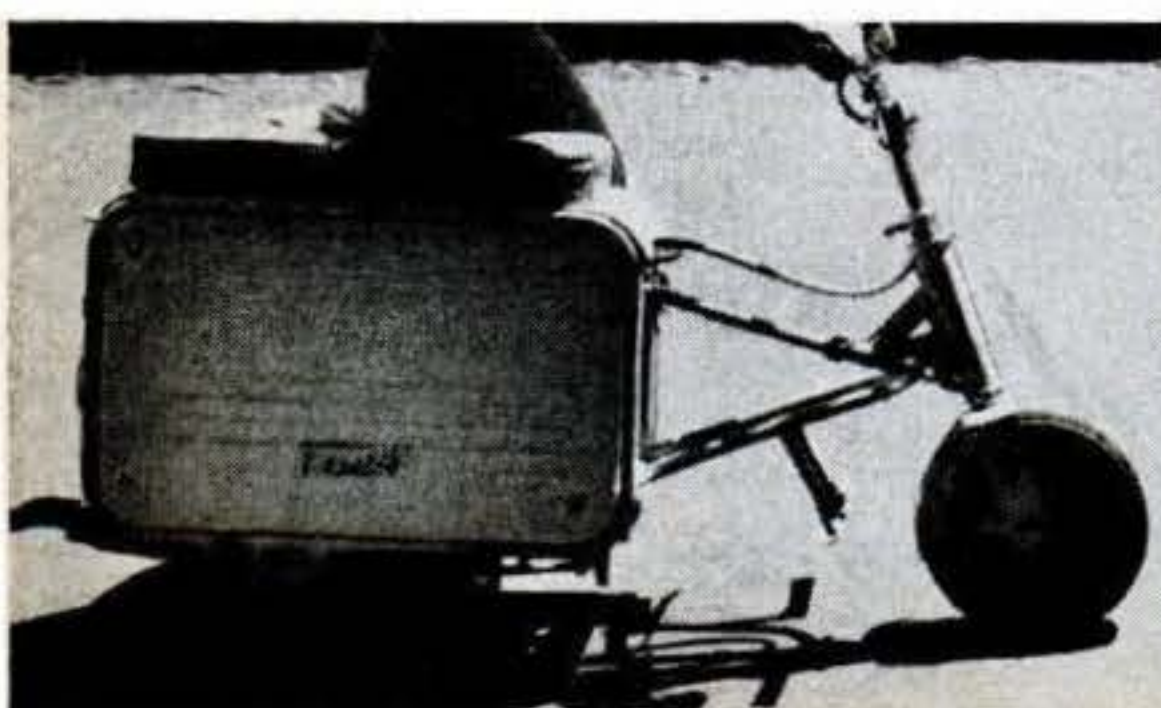
Slim folder

Slim for storage, contour-molded for sitting, this plastic chair gives a new look to the old standby folding chair. Gotham Industries (410 Jericho Turnpike, Jericho, N.Y. 11753) makes it in "wet-look" red, yellow, black, and white.



Suitcase scooter

If that motor scooter looks a lot like luggage to you, there's a reason. It folds out of a suitcase for riding, folds back in to beat the parking crunch. Weight? 92 pounds. Top speed? 35. Fuel mileage? 165 mpg. Price? \$245. Availability? Not yet. Valmobile is a Swiss design made in Japan.



What's New IN ELECTRONICS

Double-duty timer

Daytime, it's a digital clock, displaying time to 0.01 second. After work, the Zetachron is a stopwatch, timing anything from eggs to sports events. AC or batteries power it. Price: \$200 to \$250, depending on model. Zeta TimeTel, 1407-G East Edinger, Santa Ana, Calif. 92705.

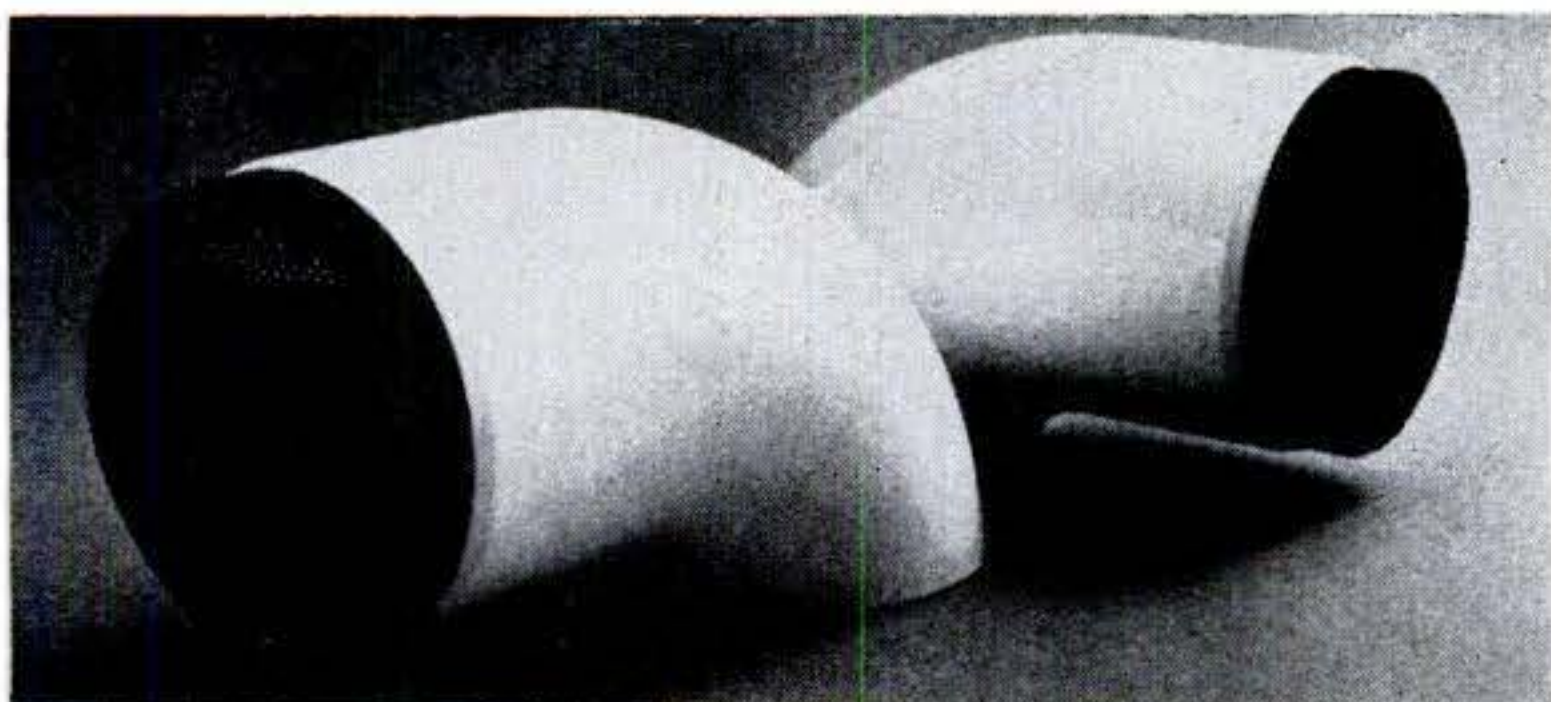


Probe thermometer

Say "aah" and slip the probe under your tongue. In 15 seconds, you get your temperature on an easy-to-read display. The electronic oral thermometer is \$25 from Edmund Scientific, 380 Edscorp Bldg., Barrington, N.J. 08007. It's battery-operated. A disposable probe cover keeps everything sanitary.

Sound benders

Can you guess why they call these Swedish speakers superbends? Anyway, they're composed of 5" bass-midrange and 1 1/2" tweeter and mount anywhere—walls, ceilings, floors, table tops. Price: \$125 each. Distributor: Intercontinental Enterprises, 69 Stewart Ave., Eastchester, N.Y. 10707.



Synthesizer kit

You and your soldering iron can make beautiful music together—if you assemble this electronic music synthesizer kit. It comes in modular form or as a complete kit from PAIA Electronics, Box 14359, Oklahoma City, Okla. 73114. The kit as shown is \$218.88.

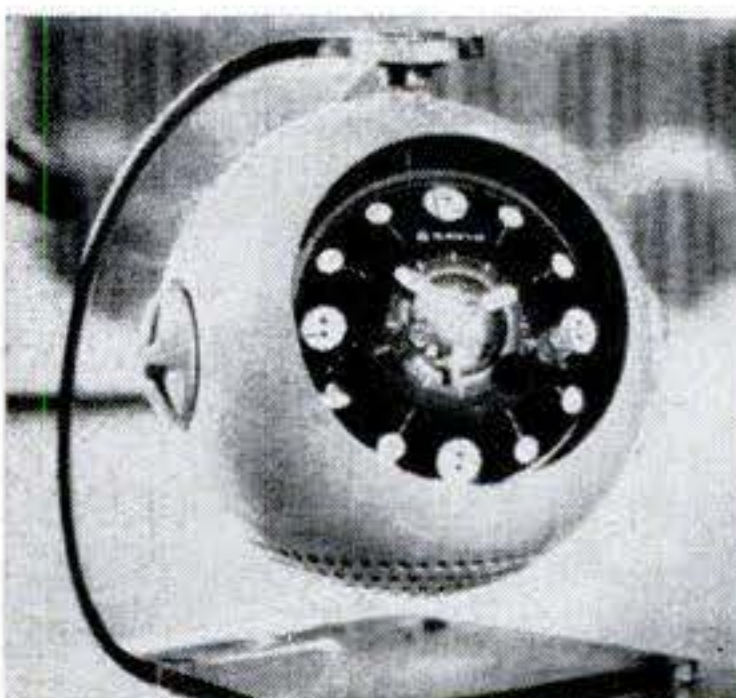


100-hour calculator

Here's a calculator you can count on—especially for long periods of time. It operates for at least 100 hours on only one penlight cell. New from Sharp Electronics, the EL-805 displays the answer on large liquid-crystal readout. It sells for \$109.95.

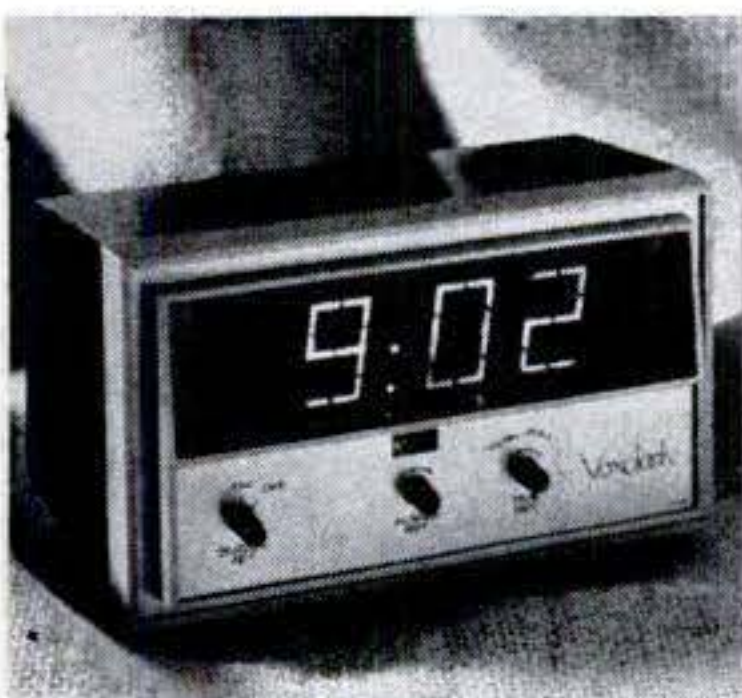
Radio/recorder

Everything's built into Superscope's new portable: AM and FM, cassette recorder, even a condenser microphone. The unit records directly off-air, too. It's AC/DC. An automatic shut-off saves battery and wear. The CR-1000 is \$79.95.



Swinger

A lucite stand supports Sanyo's new swing-and-swivel clock-radio. Made for office, den, bedroom, or living room, the battery-powered RM1800 portable has a built-in AM radio and analog clock with alarm. It sells for \$34.95.



Sleeper's pal

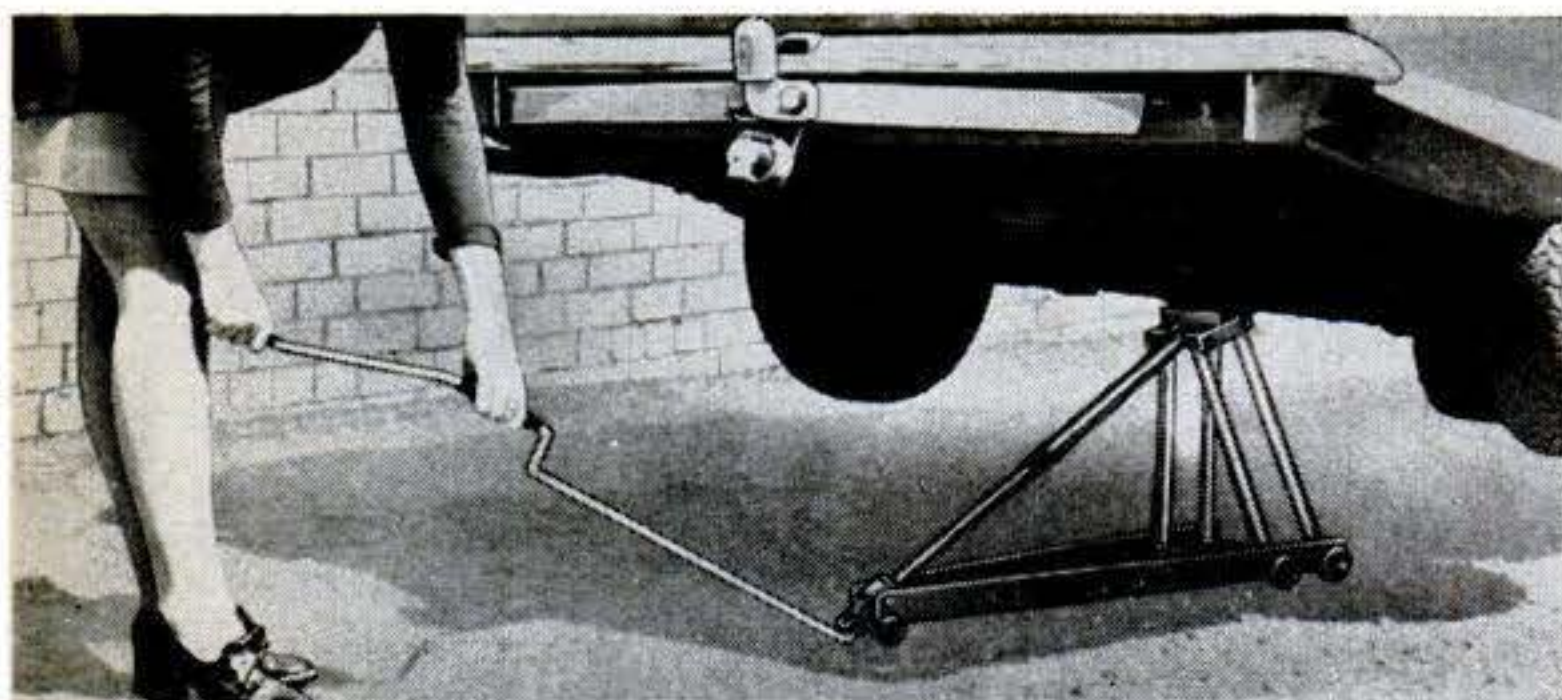
Finally, an alarm clock with a heart—or, perhaps, ears. Tell the Voxclock to be quiet and it does—at least for another two minutes. The wake-up beeper alarm is voice-actuated and resets automatically after you speak. It's \$69.95 from Vox Industries, Hwy. 20 East, Independence, Iowa 50644.

What's New FOR YOUR CAR



Tire guide

Sliding this guide under the wheels won't make tire changing fun. But removing or installing a wheel is easier, says the maker, because you're able to guide it off and on the wheel bolts with little effort. It's \$5.78 from Here's Hal, Box 158, Haddonfield, N.J. 08033.



Low weight, low price, for a high-lift jack

Only a fraction of the price and weight of a professional hydraulic trolley jack, this British high-lift jack does much the same job. The load pad swings up on four pivoted legs, and is raised by a screw turned by a long crank handle hooked to a universal coupling. The triangular base rolls on six wheels that spread the load. The Handijack weighs 17 pounds and flattens, for storage, to three inches. In Britain, it's about \$27. Eflow Developments, Old Teme Bridge, Lower Wick, Worcester WR2 4BY, England.



Electric muscle

Need extra muscle for lifting or pulling loads? Black & Decker's offering four new portable electric winches. They operate off your car battery, and have a max working load of 750 to 1500 lbs., with forward and reverse operation and automatic braking. Prices: from \$100 to \$160.



Drink dispenser

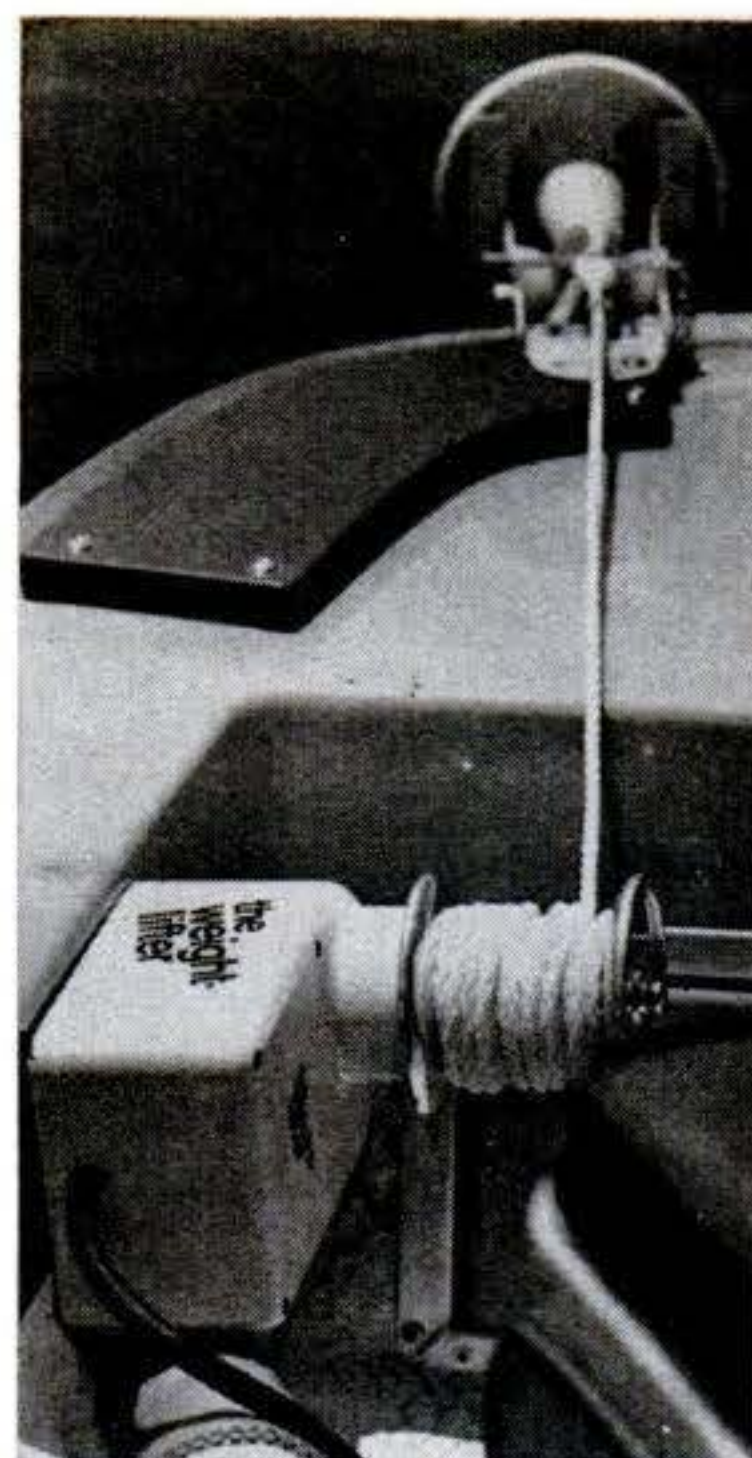
What's a Humper? Well, it fits over your car's transmission hump, all ready for the coffee break. Foam insulation keeps hot drinks hot and cool drinks cool for "a long time," says the maker. It holds a gallon. With spout and cup holders, it's \$14 from Travel Aids, Box 3016, San Francisco, Calif. 94119.

What's New IN BOATING



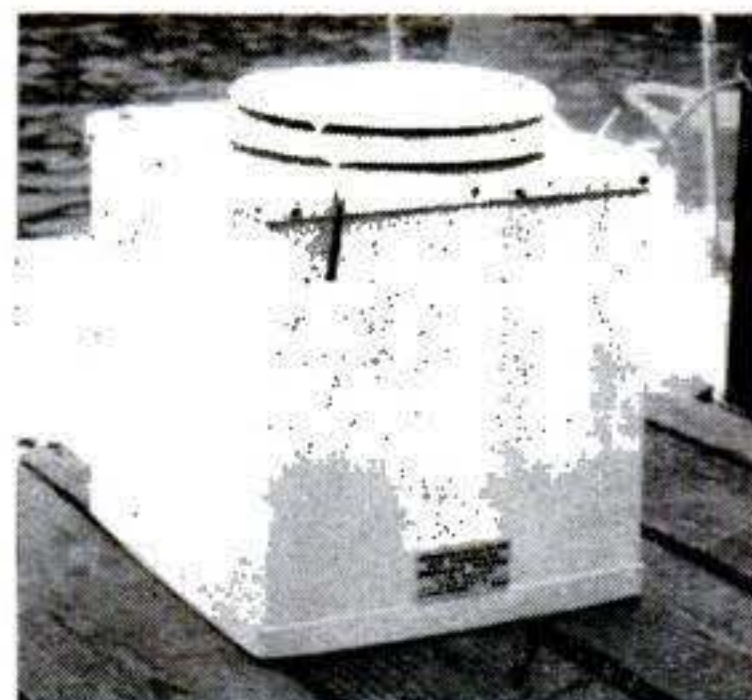
Self car-topper

Here's a way to car-top your boat by yourself. Tempo's new Boat Loader lets you hoist your boat on the roof of your car, wheelbarrow fashion, on a guide roller. Then you just lash it down. It's \$59.95 for the whole kit. Maker: Tempo Products, 6200 Cochran Rd., Solon, Ohio 44139.



Anchor hoist

Weightlifter's the name of this new electric hoist that'll lift anchors up to 190 pounds out of the mud. Operating off a 12-volt battery, the spool holds 90 feet of 3/16-inch rope. You can mount it anywhere. Maker: Herschede Hall Clock Co., Starkville, Miss. 39759. It's \$99.95.

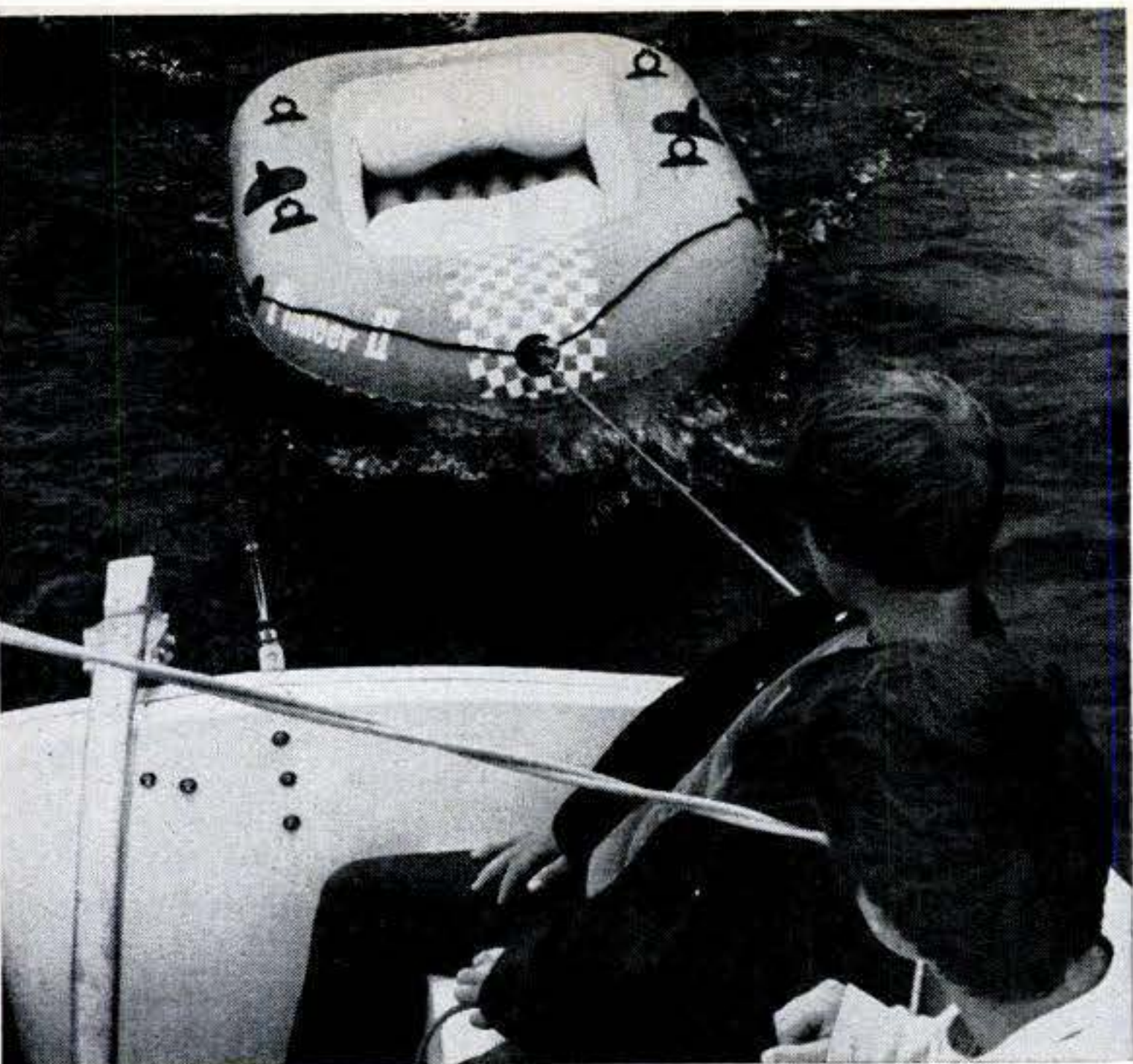


Marine toilet

"A miniature sewage plant" the Petmar Corp. calls its Digest-O-Matic, a 50-pound marine toilet. Without outside connections, the unit converts waste to an odorless effluent, and evaporates it, using four aeration pumps. It's \$495. Petmar Corp., Dunedin, Fla.

Lightweight canoe

Even heavyweights can use the 17-foot Michi-Craft canoe. It weighs only 78 pounds, yet carries 10 times that much. It can take outboards up to five hp with the mounting bracket shown at left, has a natural aluminum finish. Michi-Craft Corp., 19995 19 Mile Rd., Big Rapids, Mich. 49307.

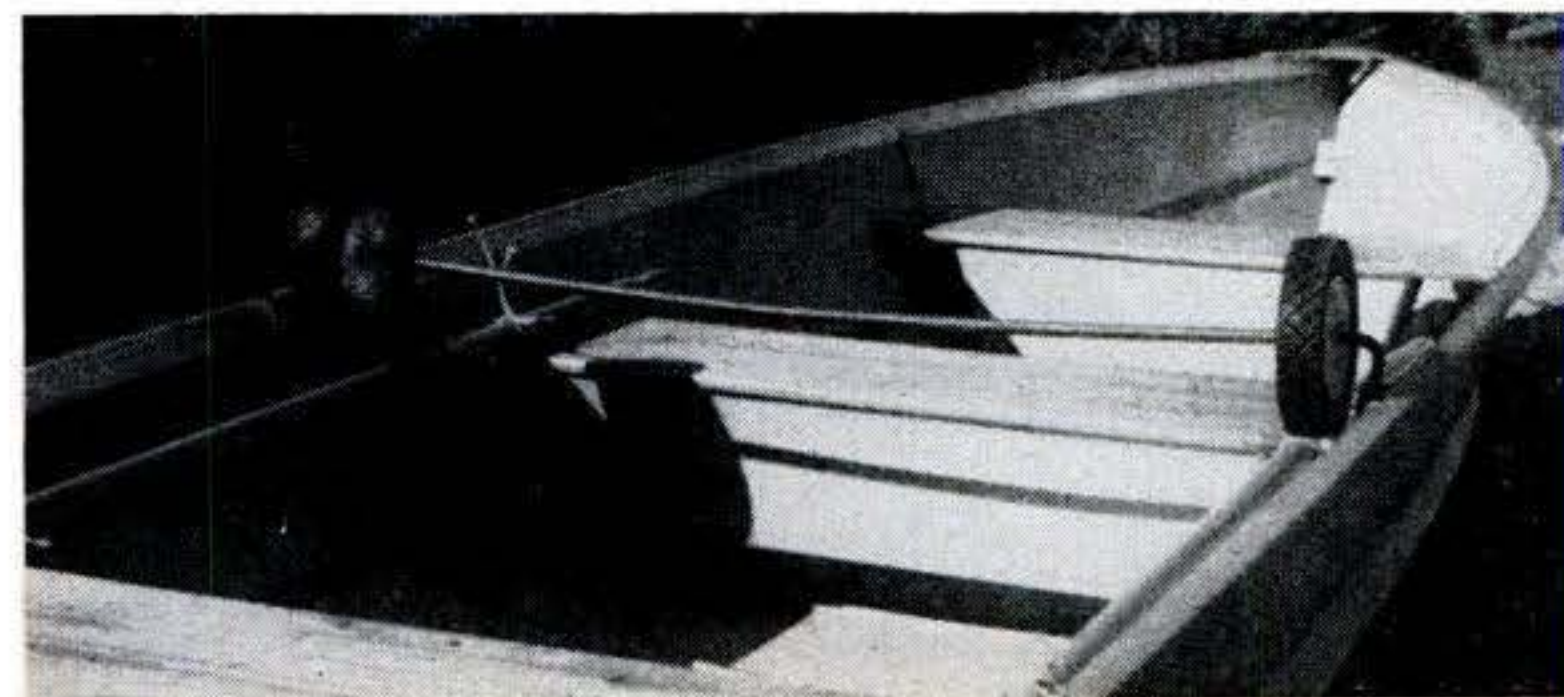


Inflatable

No place for a conventional dinghy? Take a look at Gloy's new Pioneer II, a 6½-foot, 500-pound-capacity craft that seats two adults and two kids. Five separate air sections reduce the puncture problem. Boat, oarlocks, and carrying bag are \$30. Gloy's, 899 Broadway, New York, N.Y.

Cat sailer

That gal at right is hiking on the trapeze of Chrysler's new 6½-foot catamaran, the Musketeer. The maker claims she (the boat) has excellent tacking, pointing, and load-carrying capability, carries four comfortably. Marine Products Group, Chrysler Corp., Box 2641, Detroit, Mich. 48231.



Loaded tri-hull

New for '74, this 16-foot tri-hull from Signa features a teak transom-mounted ladder for skiers and swimmers. The Echo has an 18-gallon gas tank, bilge pump, and fire extinguisher with plenty of standard-equipment accessories. Max-hp rating is 100. And right below her is Signa's new Bravo Buddy cruiser, a 20-footer with two cabin bunks, head, teak doors, and 36-gallon gas tank. Motor options? 120 to 225 hp. They're both made by Signa Corp., Box 501, Decatur, Ind. 46733.



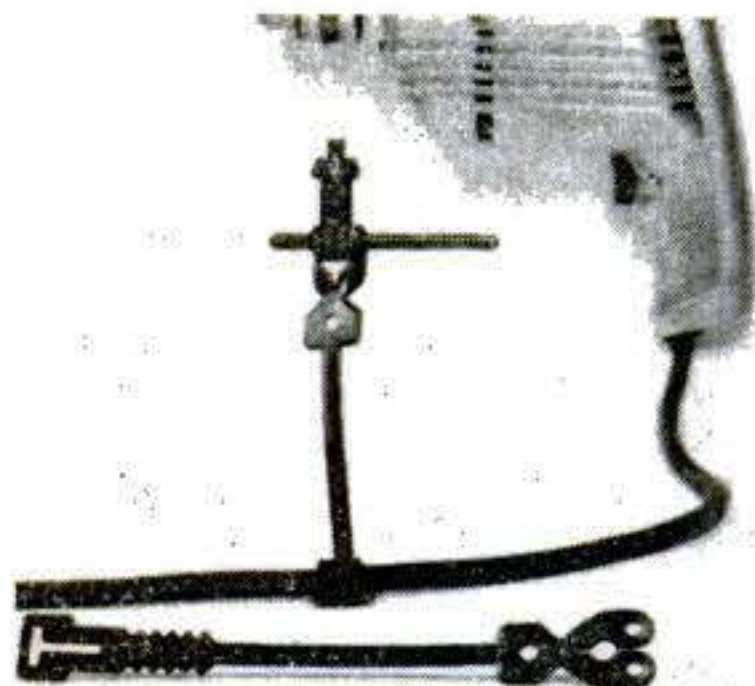
Boat toter

Tired of lugging your boat around? The Roll-Ur-Boat, a wheel-axle kit that inserts in the oarlocks, lets you pull your boat over the ground with a clearance of five inches. One man can now handle 150-pounders. \$14.95 from Roll-Ur-Boat, 400 Foster St., Iron Mountain, Mich. 49801.

Digital compass

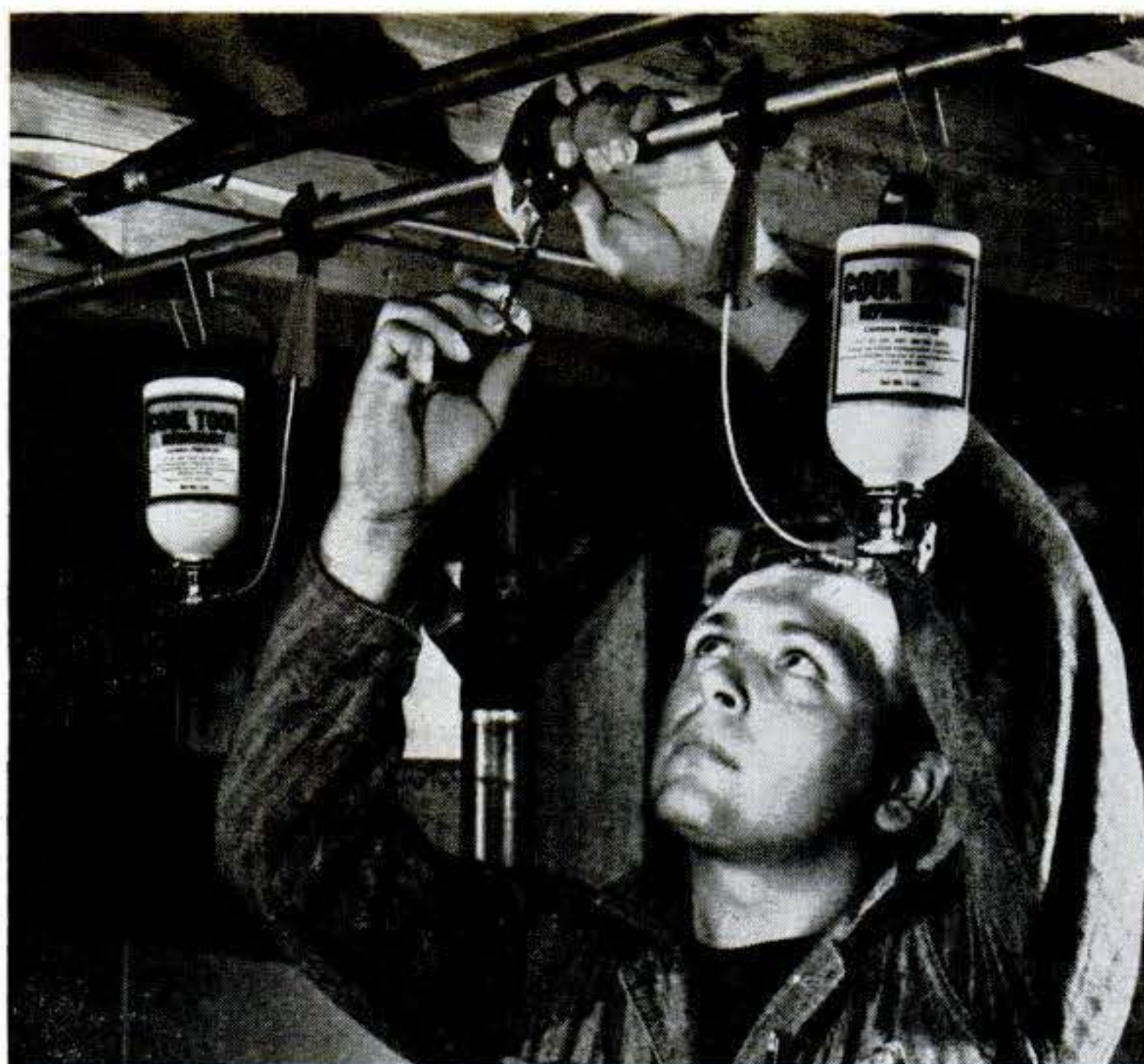
You'll know your heading in any part of a boat with the Digicourse System 100. It consists of a sending unit, installable anywhere in a vessel, and up to 15 digital-readout units. Readouts are legible up to 20 feet away. The system, for big boats, is by Swigert, 2404 Intern'l Trade Mart, New Orleans, La. 70130.

What's New IN TOOLS



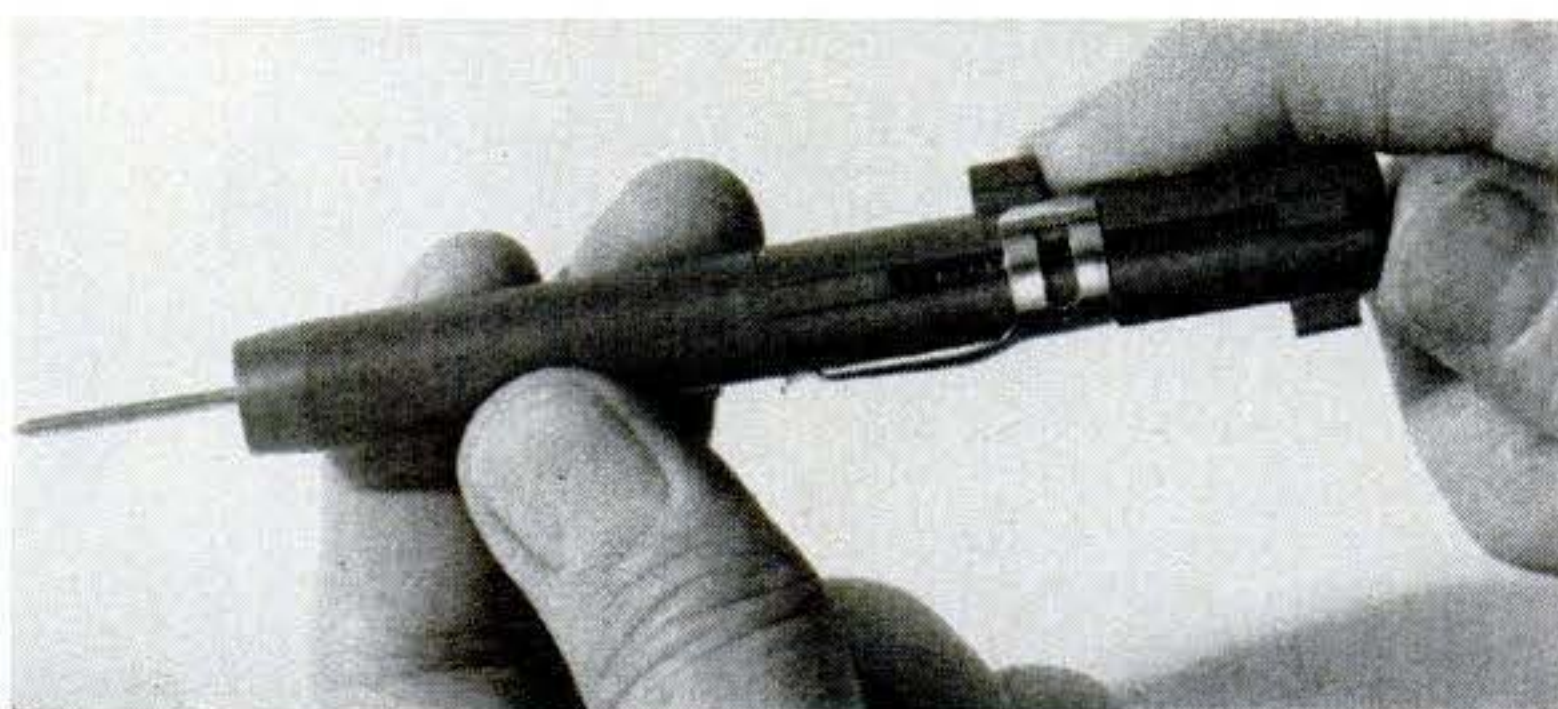
Key keeper

Your chuck key is always where you want it with this new holder developed by Allen Field Co. It's made of polyethylene, fastens quickly to any power-tool electric cord. Coastal Abrasives is packaging it for retail sales. Price: around 30¢.



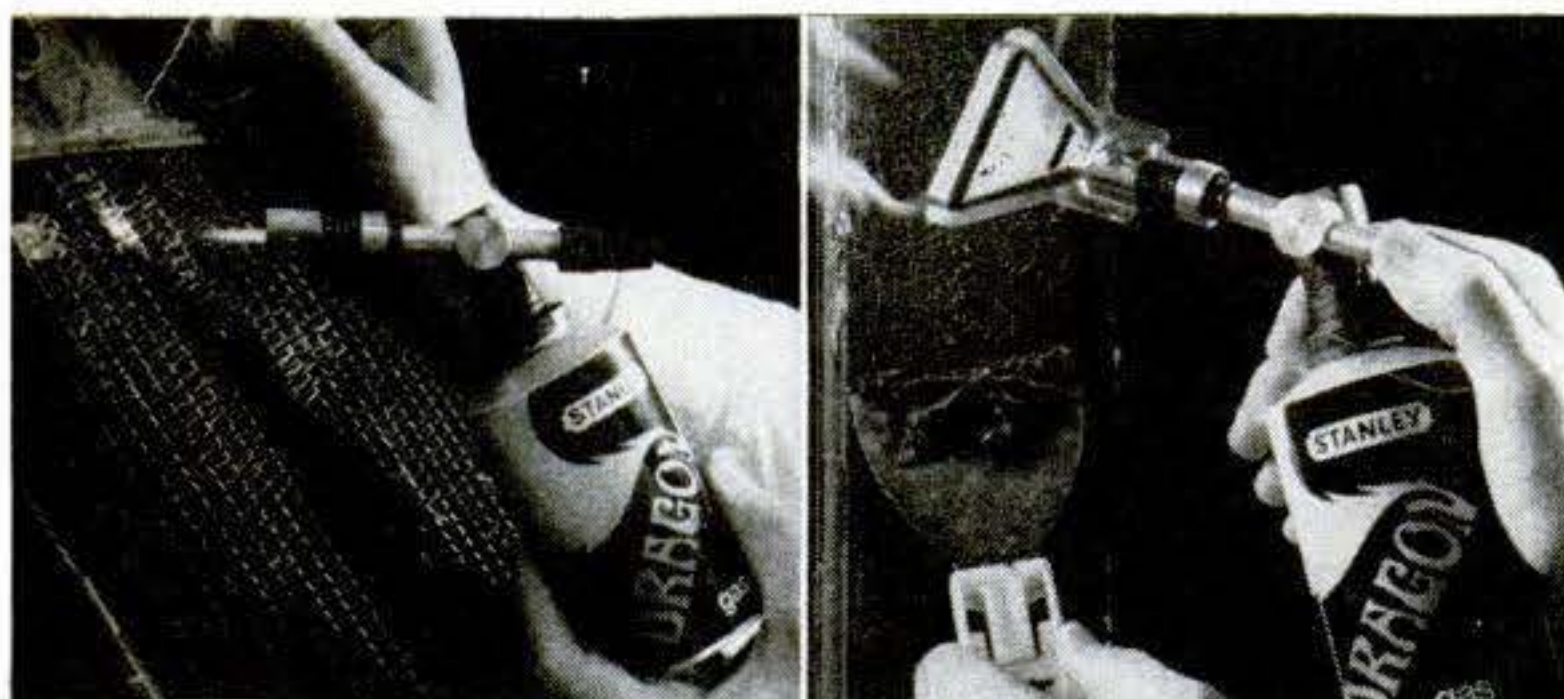
Cold shutoff

Repair or modify your plumbing without shutting off the water? No sweat for Cool Tool. It hooks up to your pipe and freezes it shut—don't worry: the pipe won't burst. Each unit—a can of freon, hose, and three freezing heads for the six common pipe sizes—is \$19.20 from Flomatic North Hoosick, N.Y. 12133.



Four-way driver

The push of a finger slides any of four screwdriver bits into position in the new James Pick-N-Drive. Blade shank mounts in a plastic carrier that yields at proper torque level to protect delicate instrument parts. Price? \$5. Maker: James Electronic Tool, Box 1482, Palo Alto, Calif. 94302.



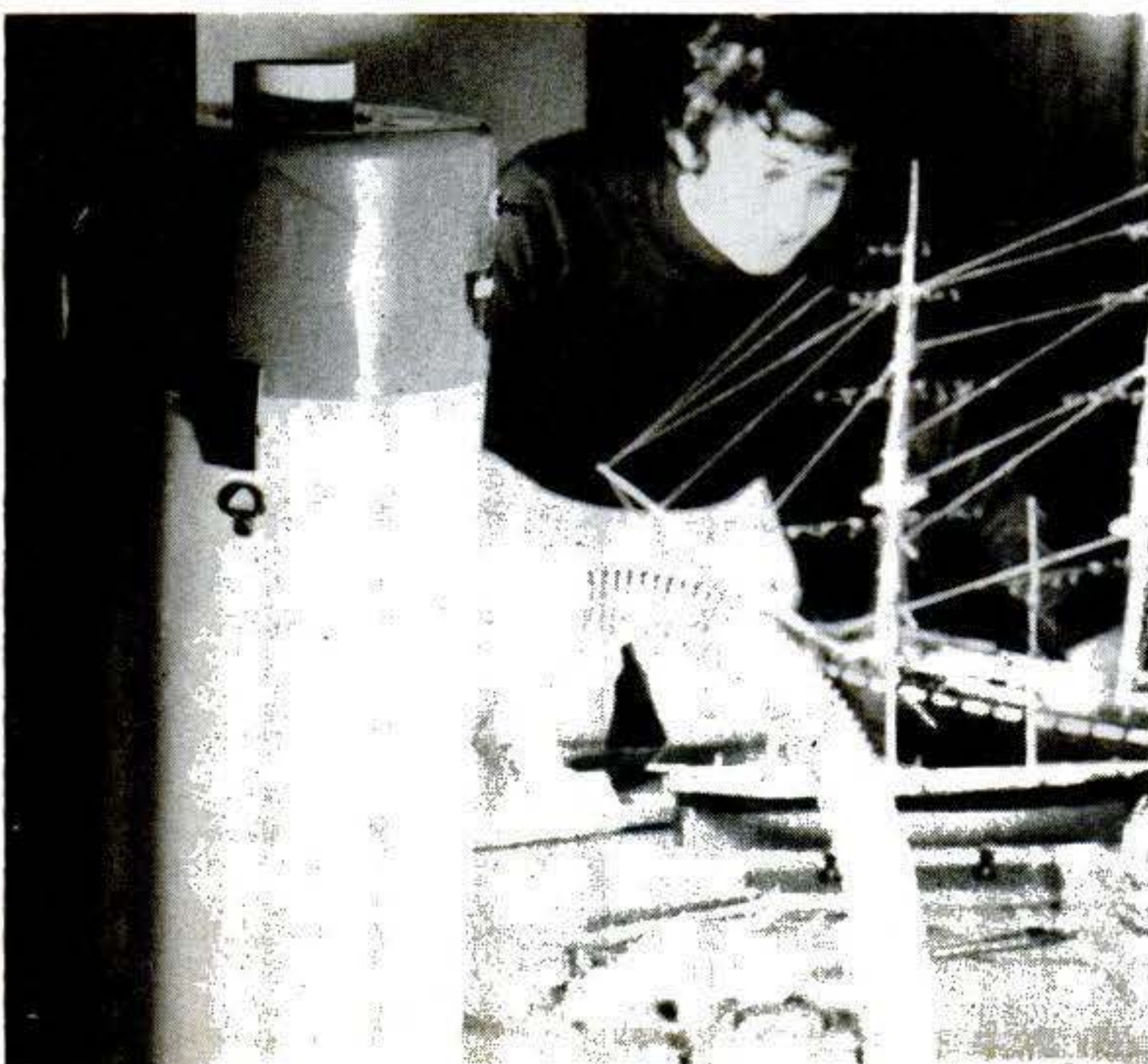
Tea heater?

The Stanley name is familiar, but the torch isn't. Why? It's made by Stanley Tools Ltd., in England. The firebreathing Dragon has two mouths: One throws a fantail flame, the other a standard pencil. Gas release is controlled by a twist valve.



Cordless gun

No cord to cramp your style with Wen's new battery-powered pencil soldering gun. Rechargeable ni-cads give up to 100 connections per charge. The Model 17 heats up in five seconds, has a spot light, and a work range equivalent to a 15- to 25-watt pencil. Weight? One pound. Price? \$20.



Wall hanger

Why lug a vacuum cleaner around your shop when you can hang it on the wall? Hang-Up Vacs come in four models (two can suck up water), at prices from \$50 to \$80. The 18-foot hose should reach any part of your shop. Special brackets secure it to a wall or column. Shop-Vac makes it.

Ball-point etcher

Loan your tools out? You might even get them back if you label them with this etching pen. Acid flowing through a ball-point tip etches most metals. The cartridge-loading pen is \$7.75 from the Tool Crib, 17 Thayer Circle, Randolph, Mass. 02368.



What's New

IN HOME IMPROVEMENT



Tiny torch

Heat—2500 degrees of it—right where you want it. That's what you get from Microflame's Cub butane torch. Fuel comes in little cartridges that last up to an hour when soldering, somewhat less when brazing. Microflame, 3724 Oregon Ave. S., Minneapolis, Minn. 55426.

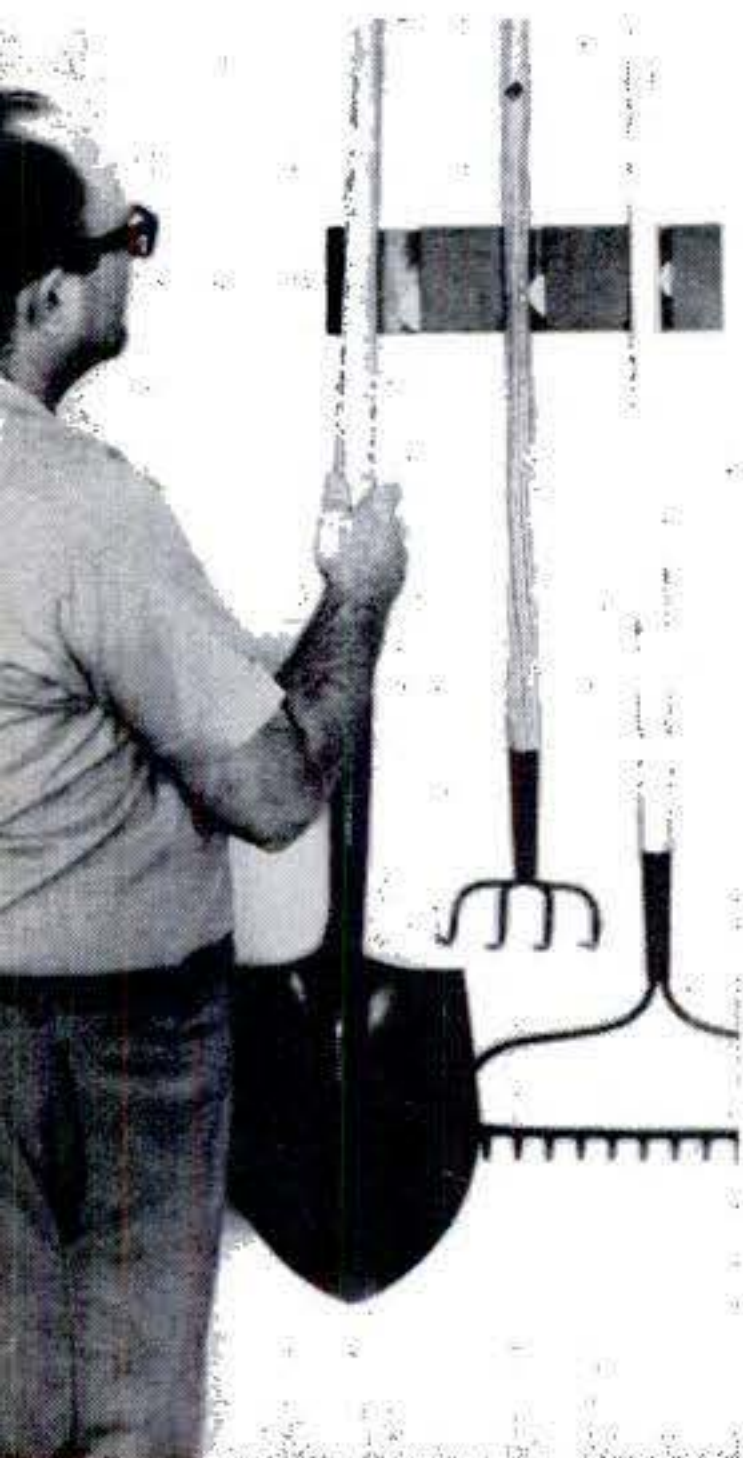
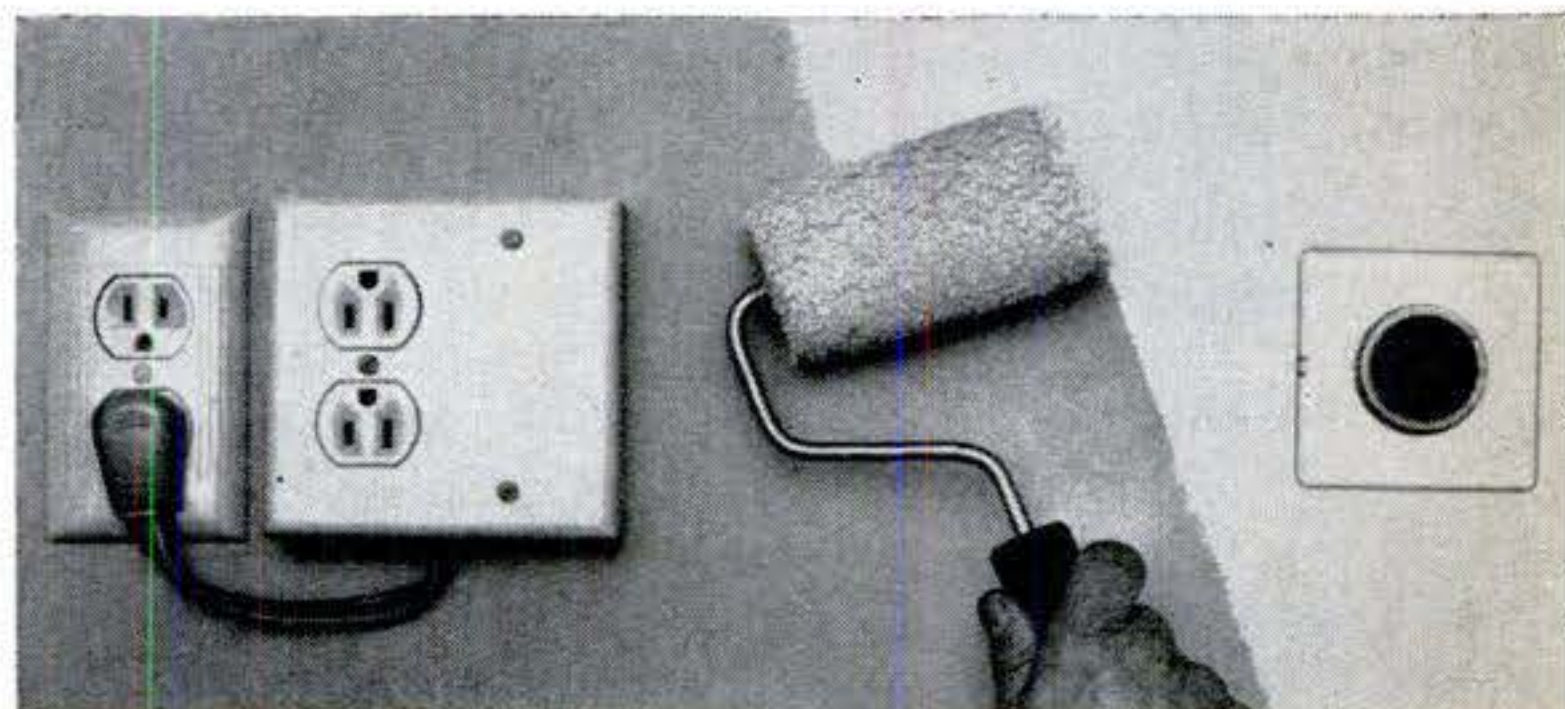
Faster fires

No more kindling, no more newspapers. BernzOmatic's Log Lighter takes their place. Set it in your fireplace, direct the jet under your firewood, and turn it on. The fire is blazing in minutes. It's \$9.95 with fuel cylinder and spark lighter.



Easy-mount switch

No need to gouge holes in your wall to install this switch—the hair-thin wires that carry its two volts stick to the surface, in a tape, and can be painted over. The touchbutton Surface Switch comes with a transformer and self-adhesive wire. Maker: Switchpack Systems, Box 670, Del Mar, Calif. 92014.



Tool hanger

Garden tools, brooms, shop tools—Hang-All puts them all up against the wall. Slip the handle into the unit, and it locks in place. Lift to remove. The secret: moving rollers. A three-tool rack is \$2.49 from Royal Krafts, 6261 Variel Ave., Woodland Hills, Calif. 91346.



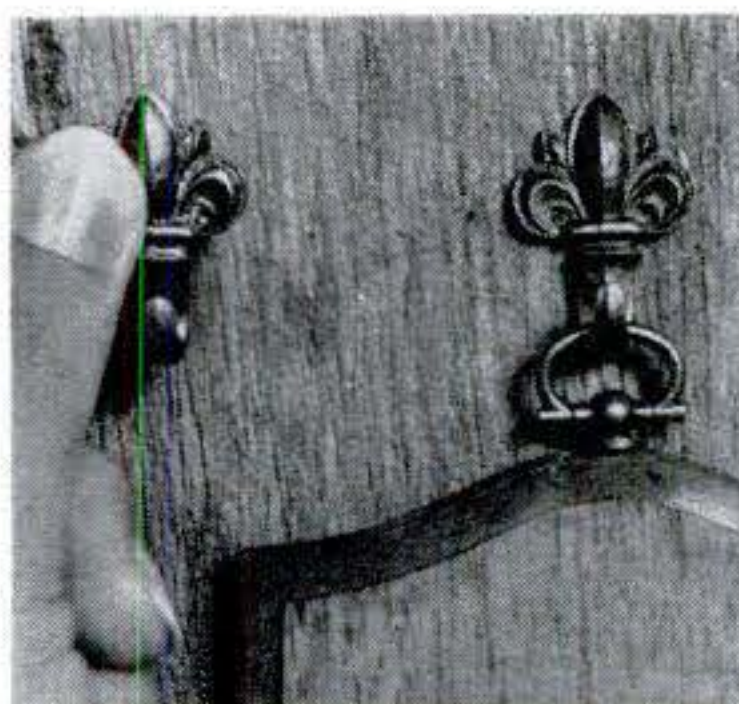
Whirlpool stairs

Add these stairs to your pool and you get more than easy entry and exit. You get a whirlpool bath, too, with bubbles that swirl away aches and tension. The one-piece fiberglass, vinyl-lined unit is by Cascade, Talmadge Rd., Edison, N.J. 08817.



Fuel saver

Install a humidifier in your hot-air system and you'll save fuel this winter. Here's one that's easy to install. Cut a hole in the duct, slip it in, screw in place. A saddle T connects it to your water line. Turbo-Flo is \$33 at heating supply outlets. Leigh Products, Coopersville, Mich. 49404, is the maker.



Hangman's hook

Here's a hanger so stylish you won't want to hide it behind a picture. It's the Homecraft Push-Pin Hanger. Thumb pressure drives it home in most walls, but it can take hammer blows if need be. Comes in four styles—Fleur de Lis, Colonial, Rose, and Eagle—and brass or silver finish.



Neat idea

Trash-disposal problems are in the bag with Rack-Sack. The rack mounts to walls or doors, holds a roll of 30 plastic bags. Fill one up? Tear it off—another takes its place. Sacks and rack are \$5.98. Refill rolls are 98¢. Galree Products, 105 Hudson St., Jersey City, N.J. 07302, makes them.



Boeing AMSTOL, 120 ft. long, will carry 27,000 pounds.



Wing of McDonnell Douglas 124-ft. jet spans 110 feet.

Medium-Range STOLs Get Set

Coming: four 500-mph jets that will take off and land on 2000-foot runways

By DOUG GARR

STOL—for short takeoff and landing—you've heard about it many times. It may have sounded a little different in the past; like QUESTOL, for "quiet experimental" or V/STOL for "vertical."

Now there's a new plane in the works. It's called AMSTOL by the Air Force, for "advanced medium-range short takeoff and landing."

Recently, the Air Force awarded contracts to McDonnell Douglas and

Boeing to build two prototypes each of AMSTOL jets. And the contracts are for plenty: \$95 million for Boeing and nearly \$86 million for McDonnell Douglas.

Whatever the acronym, the STOL idea is still the same: The planes are designed to do big-plane work (large payload, fast cruise speed), yet be able to land at small-plane airports. The ultimate goal of STOL is to clear airport traffic jams in larger cities and develop an efficient short-haul transportation system.

We've been promised STOLs for quite some time now. The big problem has been procuring R&D money; nobody seems to like the idea of jets landing in his backyard—no matter how convenient it might be.

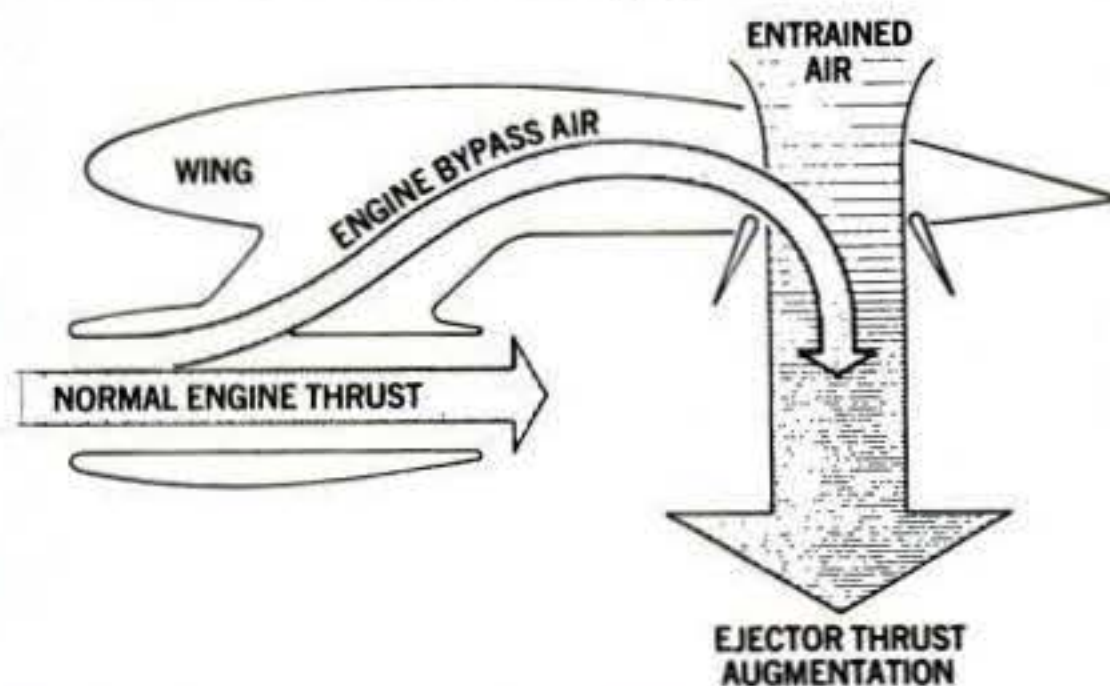
Naturally, the Air Force contracts are for military-cargo prototypes, but there is already speculation as to the feasibility of adapting the designs to commercial airliners. J. J. Foody, deputy manager of the Boeing program, admits that their proposal, if modified, has a "possible use as a passenger plane."

Each company's design is radically different in its wing/engine/flap approach—essential to STOL's low speeds—yet similar in size, speed, and fuselage design.

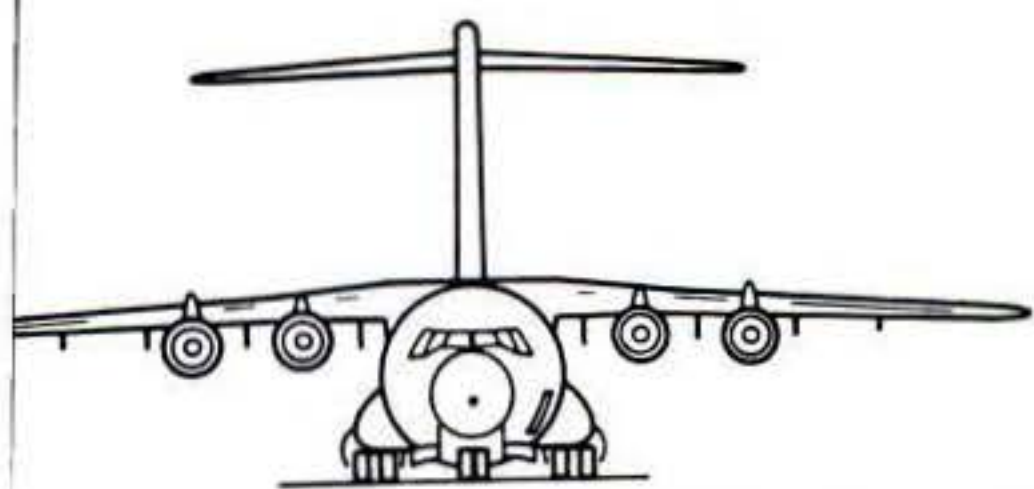
The Boeing design. It's the least conventional of the two. The fuselage will be about the size of the 727, with a T-tail like the 727. The engines will look like monstrous elephant trunks mounted above and



And the newest V/STOL



Bell Aerospace V/STOL proposal uses the most interesting wing technology. Called "cold thrust augmentation" (CTA), minimum drag and maximum lift are produced by ducting air downward through slots in the wing. About 50 percent of engine air is bypassed through wing nozzles located in spanwise slots in the wings. The wings look like an accordion at low speed but flatten out during cruise. Artist's concept is shown at left; no contract has been awarded, but wing has been wind-tunnel tested.



The McDonnell Douglas jet will have four engines, and a T-tail towering some 43 feet above the ground. The fuselage will be about 18 ft. wide, nearly as fat as the wide-bodied jets. The cargo envelope will measure 11 by 12 by 47 ft. Target date for first flight tests of this and Boeing prototypes is mid-1975.

o Take Off

forward of the wings. Power will be in the 45-50,000-pound-thrust range (rumor has it the engines will be GE model CF650s).

The engines will be mounted above the wings to increase upper-surface airflow. When the flaps are extended, the jet exhaust will travel backward and downward, generating high lift at low speeds.

Cruise speed would be in the Mach 0.7 range (just under 500 mph), yet landing and approach speeds should be a pokey 85-95 knots—less than the cruise speed of a Cessna 150. Range will be about 1000 miles and, its designers hope, the jet will take off and land on a 2000-foot strip.

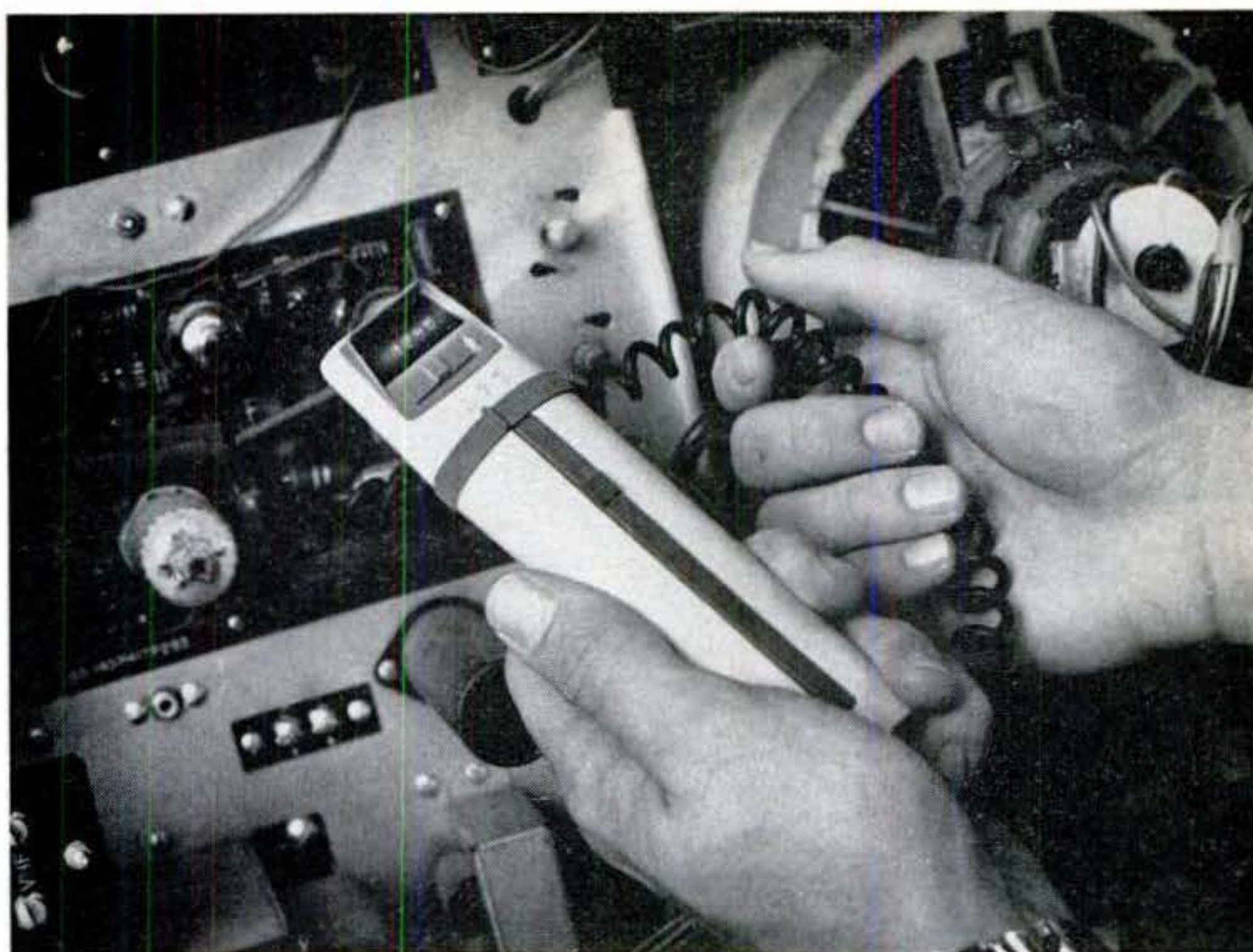
The McDonnell Douglas design. This ship will be just about the size of their DC-9-30, but the body will be much thicker, almost as big as a wide-bodied jet. Cruise speed will be about the same as the Boeing plane (about Mach 0.7) and the jet will also have short-field capability (2000-foot runway) at a gross weight of about 150,000 pounds.

Also T-tailed, the McDonnell Douglas jet will use four Pratt and Whitney JT8D-17 engines delivering 16,000 pounds thrust each.

The engines will be mounted below the wings, yet closer to them than on conventional jets. Reason? The externally blown flaps need added jet air thrust to get extra wing lift needed at the STOL's critically low speeds. Externally blown flaps in full down position extend longer than conventional flaps, "almost like they're dragging on the ground," according to a McDonnell spokesman.

If these prototypes fly successfully, we'll be one step closer to a useful STOL system.

P 5



PERSONAL-USE REPORT

This Digital Multimeter Fits in Your Pocket

Touch the tip of this new HP 970A to the part of the circuit you wish to test and you get $3\frac{1}{2}$ digits of answer. An automatic floating decimal scales the number for you; the auto-polarity circuit tells you whether it's a plus or minus figure.

You are reading either AC or DC volts, or ohms—whichever you've selected—on Hewlett-Packard's new seven-ounce shirt-pocket digital multimeter. It will autorange through five separate ranges within two seconds, and give you a reading with an average accuracy of three percent, depending on the measurement taken. And you can take up to 2000 of them before the ni-cad battery pack needs recharging.

The HP 970A is truly an in-the-field instrument—and not just because it fits your pocket. The case, designed to fit in your hand, is stress-relieved. Drop it, and it snaps open, absorbing shock and prevent-

ing damage. The three function switches are slide-action types, and you can operate each—and hold onto the meter—with one hand.

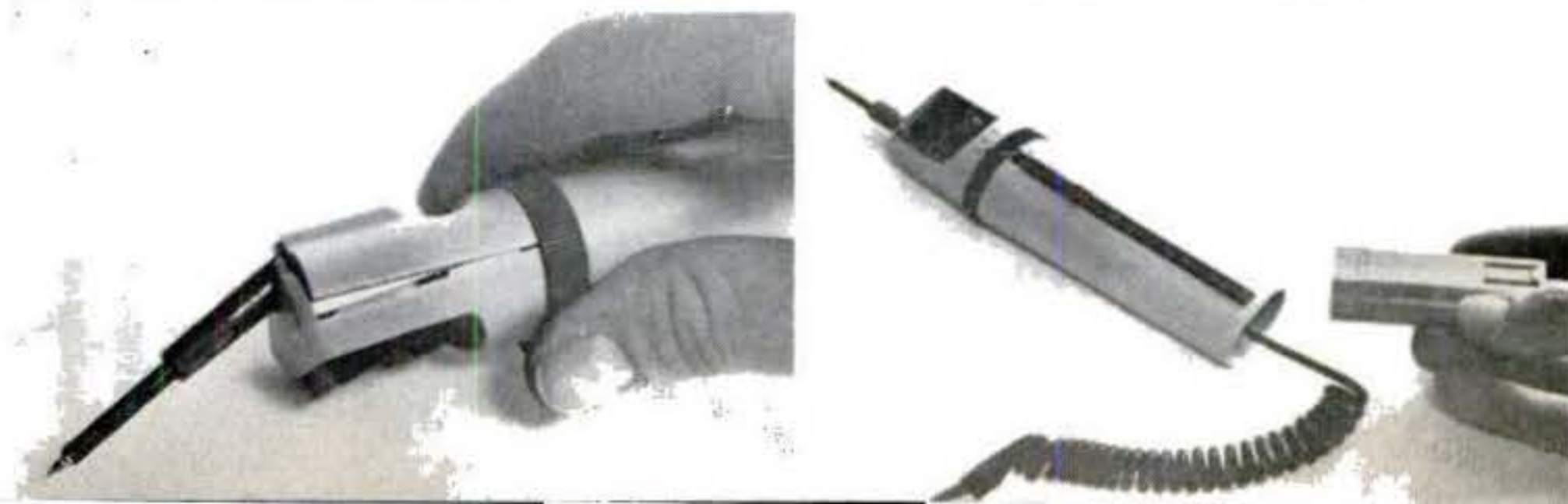
Internally, the single MOS-chip package (about two inches square) is protected from over-voltage conditions by a push-in fuse. And you've got to try hard to pop it.

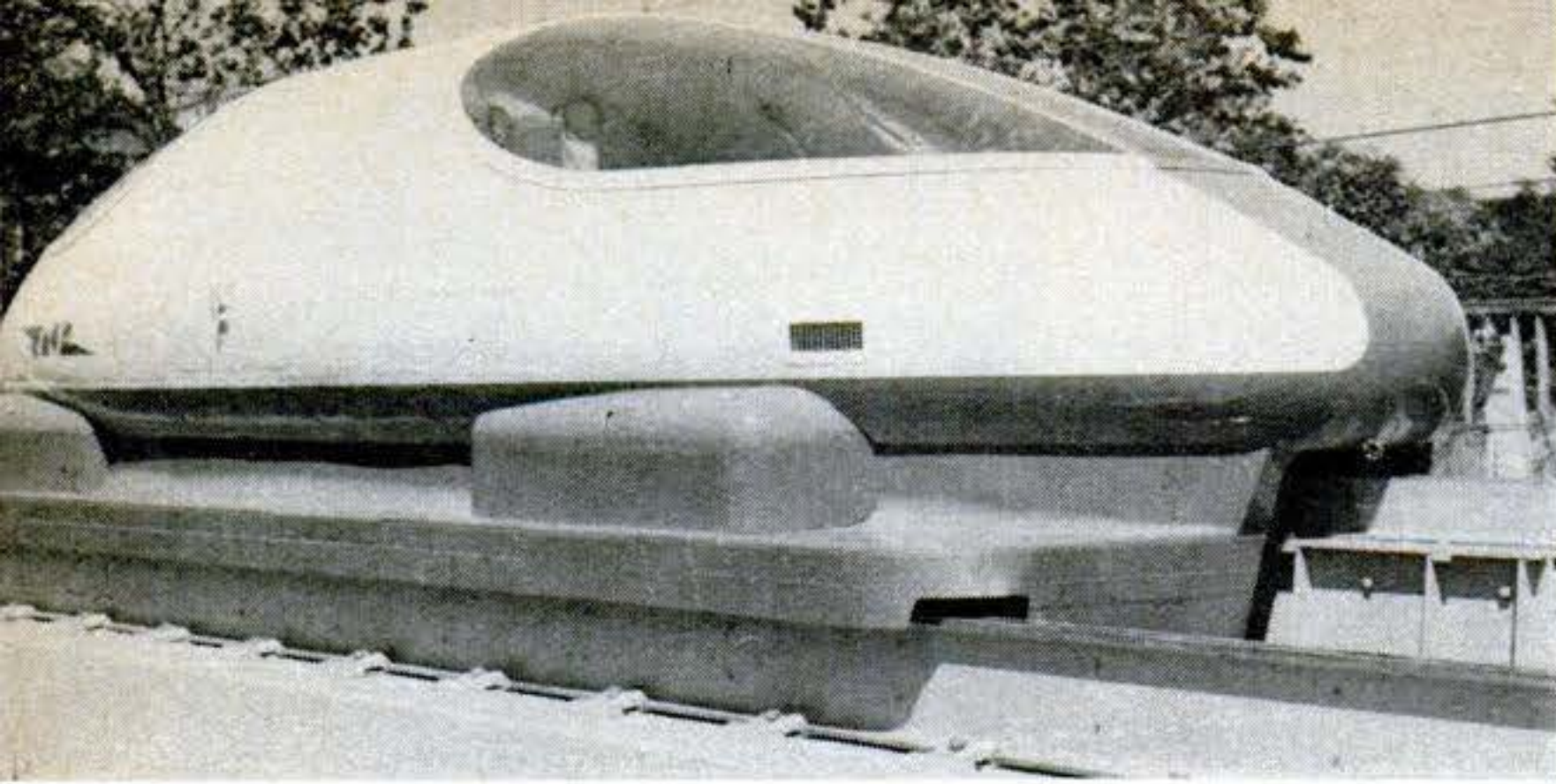
The $\frac{1}{4}$ -inch LED display is bright and easy to read—even upside down. An inverting switch flips the display over if you should find yourself in that position.

The HP 970A won't become a standard home-workshop item at \$275, but it's great for technicians, repairmen, telephone men, engineers. It comes complete with multiple probes, battery pack and charger, and belt-clip carrying case. A current adaptor is available for \$45. The HP 970A is made by Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304.—W. J. Hawkins

Stress-relieved case pops open to absorb shock if dropped or struck, snaps back with no physical damage.

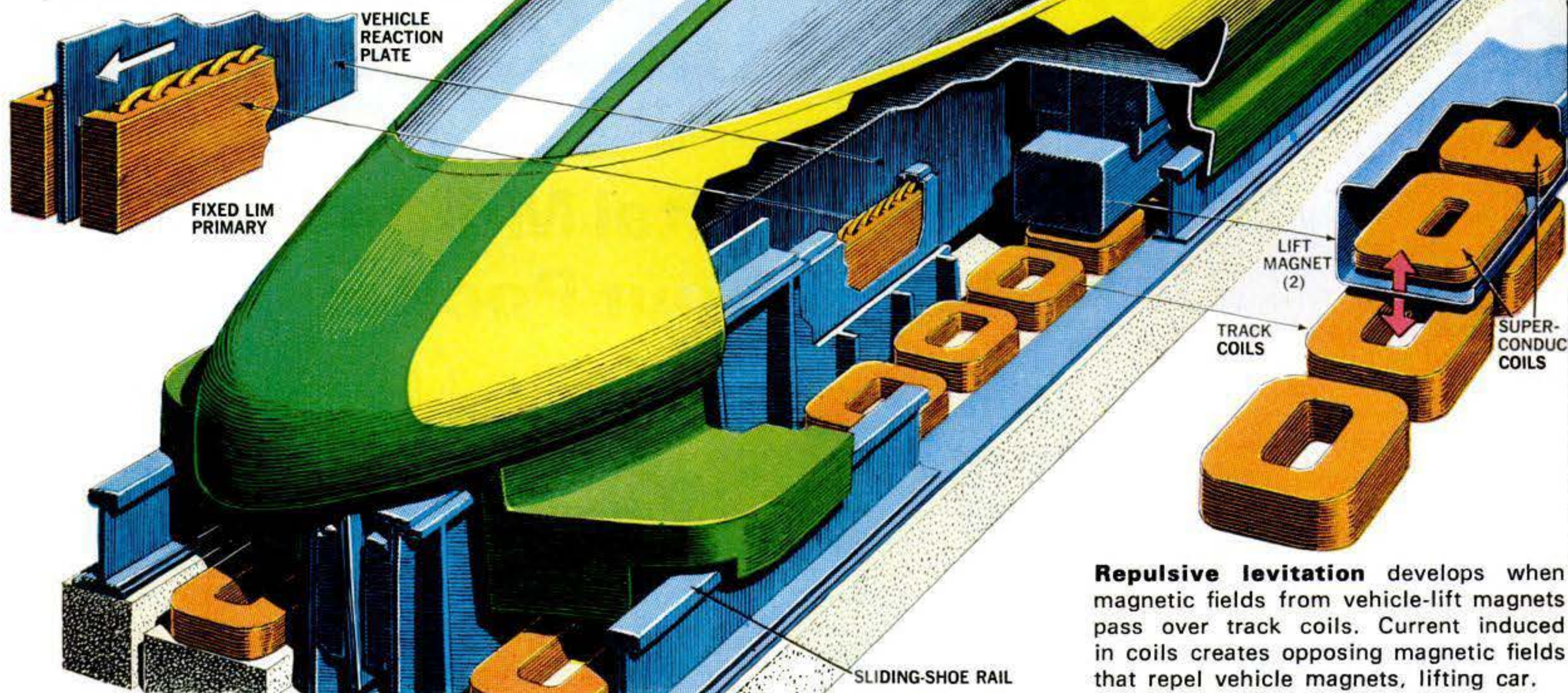
Battery pack is removable for recharging (it takes 14 hours). Extra pack costs \$25 if you can't wait.





Research vehicle built for Japan National Railways has two superconducting magnets for repulsive levitation. Two strings of passive track coils anchored in the 1580-foot guideway produce a magnetic levitation (maglev) force as the vehicle moves over them. Linear induction motors (LIMs) propel the vehicle. At slow speeds, sliding shoes support the car until a maglev force develops. The 3.5-ton vehicle, suspended four inches, has traveled up to 40 mph.

Linear induction motor (LIM) has fixed primaries spaced along the guideway. A reaction plate suspended from the vehicle is LIM secondary. As the reaction plate passes between primary coils, currents induced in the plate oppose the electromagnetic field of the primary. This opposition thrusts the vehicle forward.



Repulsive levitation develops when magnetic fields from vehicle-lift magnets pass over track coils. Current induced in coils creates opposing magnetic fields that repel vehicle magnets, lifting car.

MAGLEV: How They're

Super trains that can "fly" at 300 mph on magnetic cushions are coming. Here's a look at vehicles built to test propulsion motors and levitation hardware

By **DAVID SCOTT** / *PS European Editor* and **JOHN FREE**
ILLUSTRATIONS BY RAY PIOCH

A major revolution in high-speed ground transportation (HSGT) will get off the ground in Germany, Japan, and Canada during the next two years. Significant, but smaller-scale developments, will occur in the U.S. Wheelless trains that "fly" above special rails and guideways using magnetic levitation (maglev) are rapidly approaching commer-

cial reality. Considered a way-out idea for ground transportation just seven years ago, maglev planning should see these developments by the end of 1975:

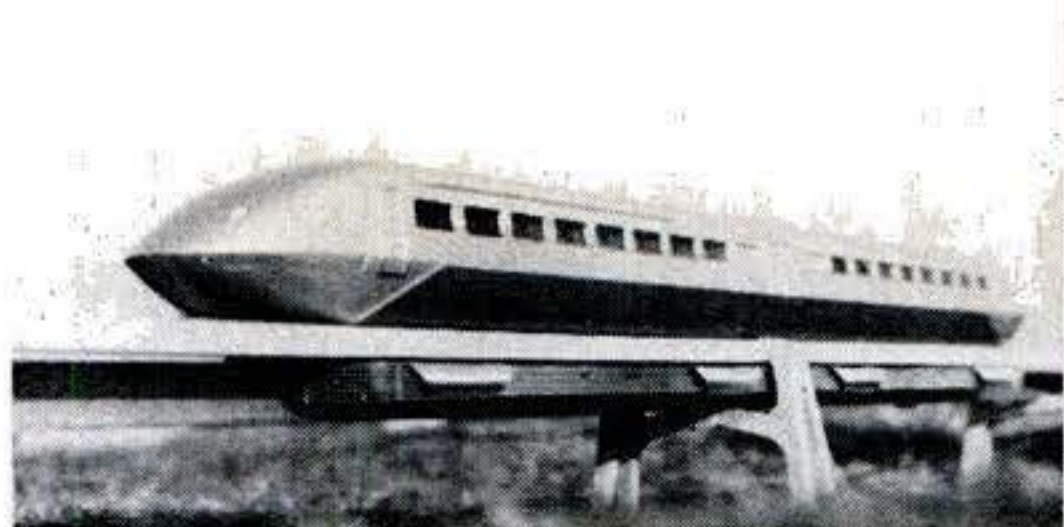
- In West Germany, three companies, with extensive government financial support, will begin testing full-scale maglev vehicles on a 46-mile proving track shaped like a

dog biscuit near Augsburg. Government funding will then be stepped up to put maglev trains on public rails as quickly as possible.

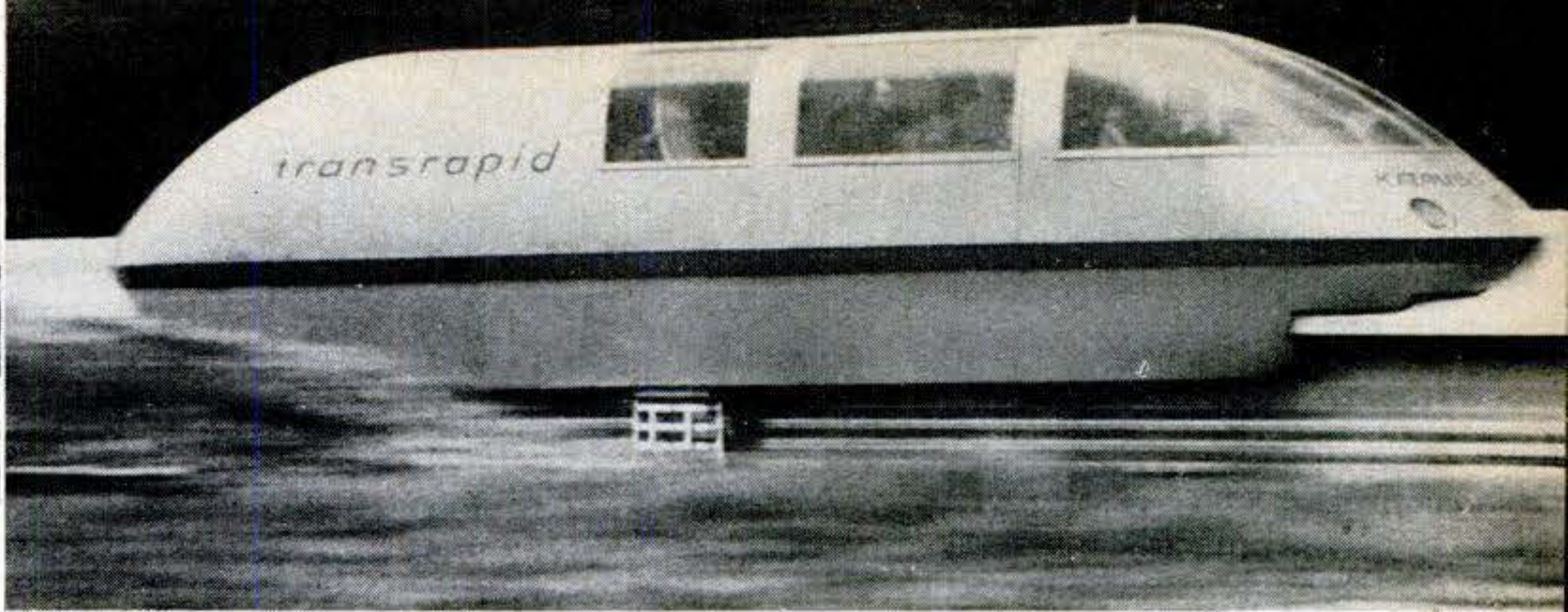
- In Japan, the Japanese National Railways should have decided which of two vehicle-propulsion systems being tested should be suitable for a 280-mile maglev link between Tokyo and Osaka. Construction may be underway on a system that by 1985 will be whisking train passengers between the two cities in about an hour.

- In Canada, a 2.5-mile maglev test track should be completed in Toronto. Krauss-Maffei, one of the three German firms, has contracted to build the maglev system. Ontario's government has said no to a

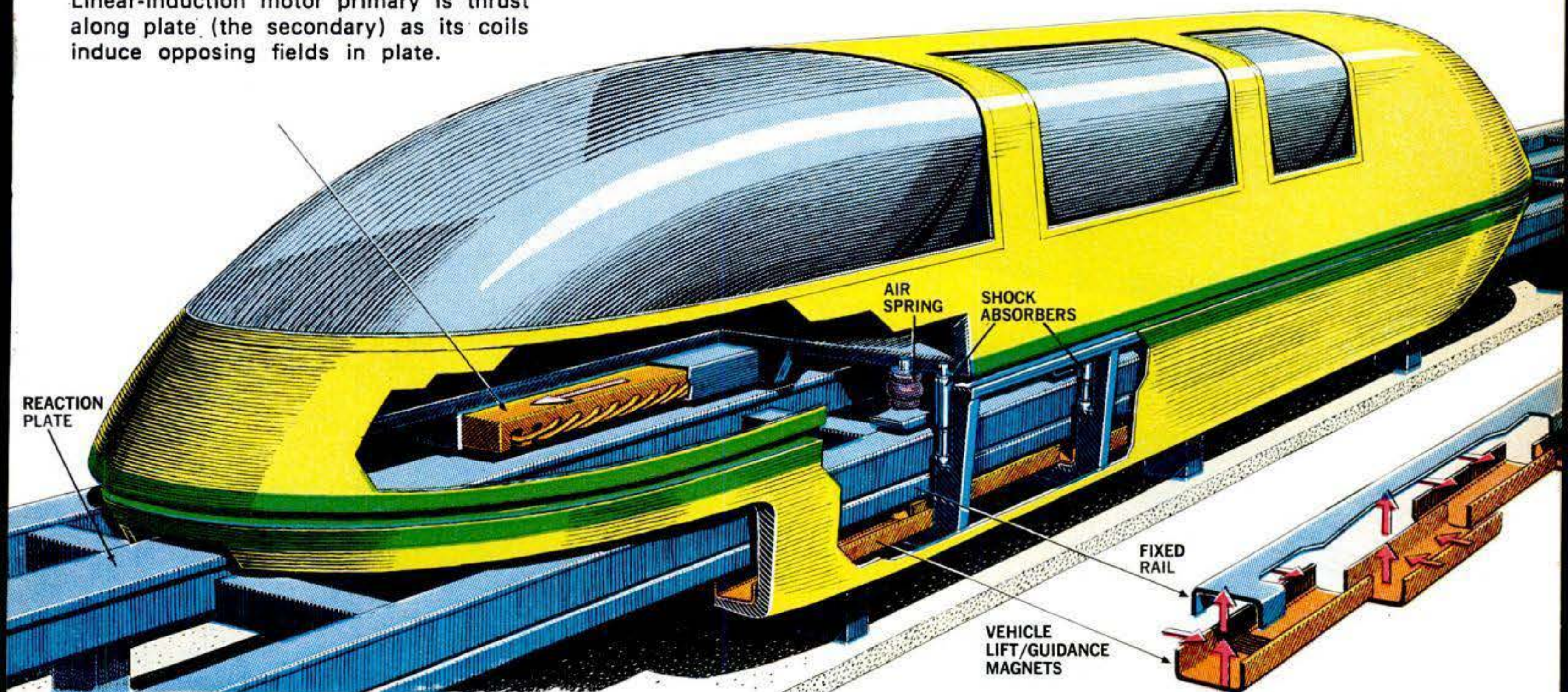
Continued



Zippering along German test track, right, is Krauss-Maffei's 11-ton test car, built in 1971. Above is a KM concept model of a future maglev vehicle.



Flat, single-sided LIM in car works against a metal reaction plate on track. Linear-induction motor primary is thrust along plate (the secondary) as its coils induce opposing fields in plate.

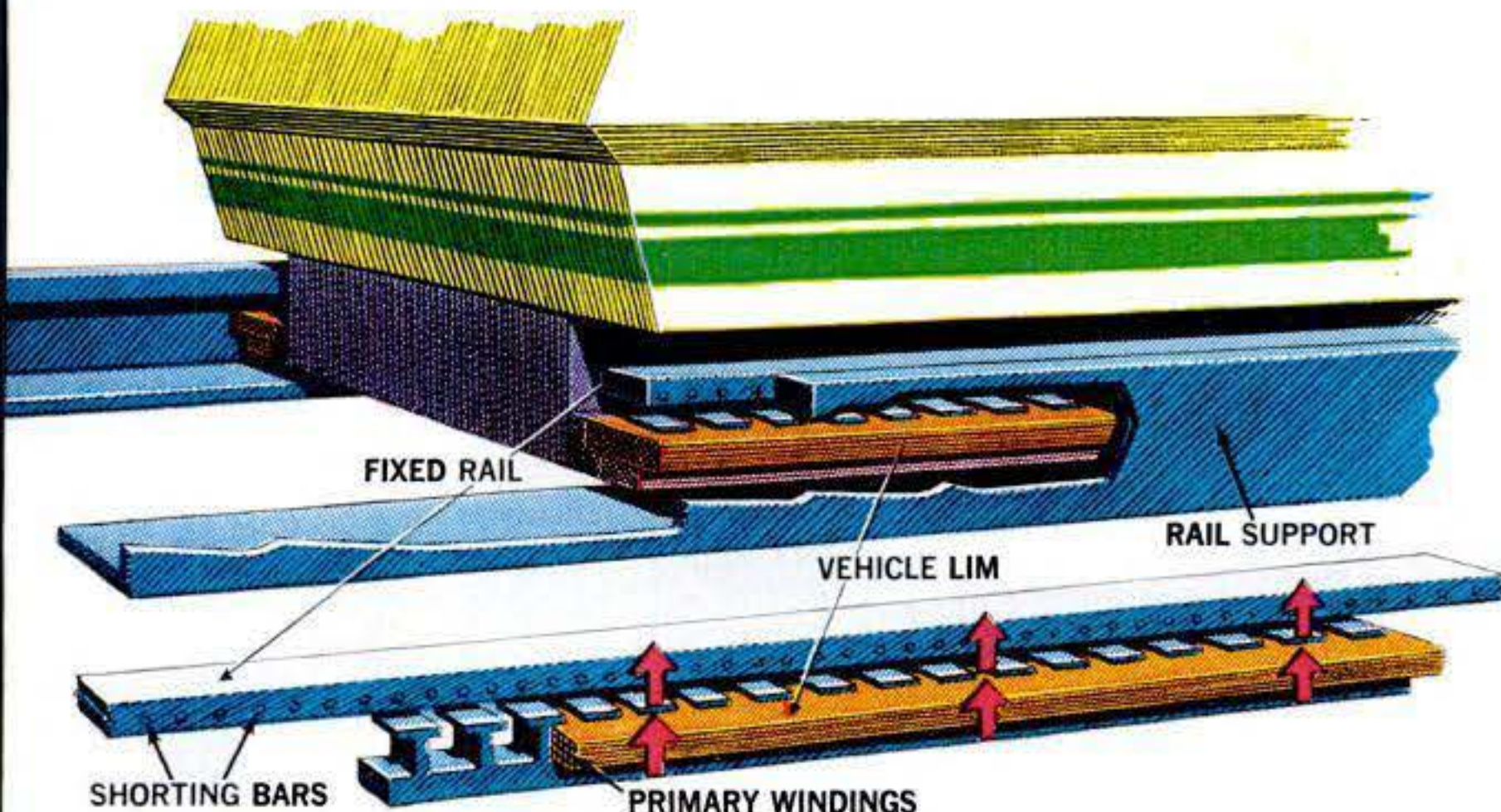


Second-generation KM research vehicle nearing completion is a modification of original car (photo above). Double-sided vertical LIM is being replaced by more powerful single-sided LIM placed horizontally under the floor. This flat

LIM eliminates the massive reaction-rail tunnel needed in original vehicle. To lift the car, unique U-channel electromagnets are attracted to the steel rails (detail, right). Sensors determine distance to rail to hold half-inch air gap. Adjoining

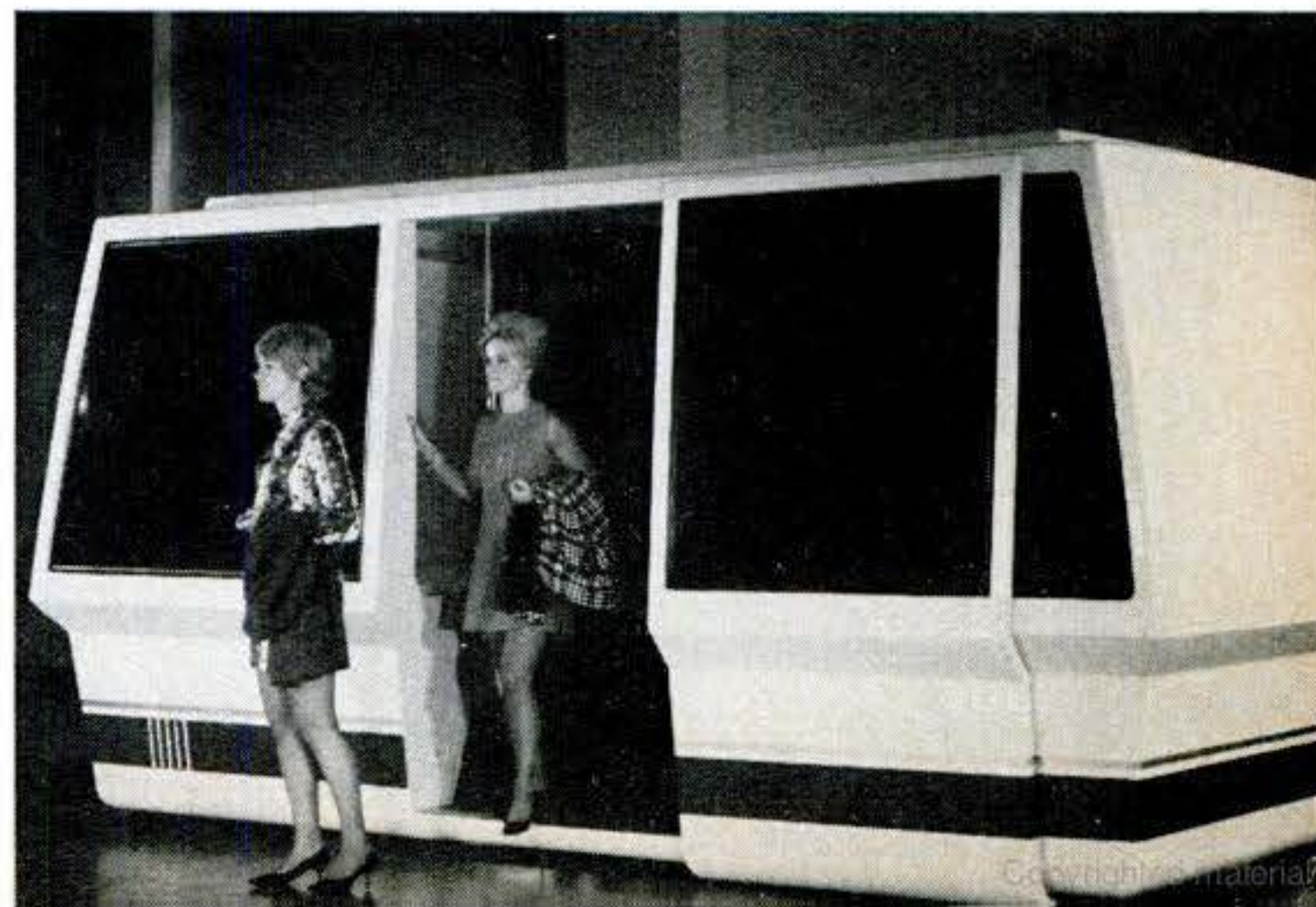
magnets are laterally offset, each pulling sideways in opposite directions to provide guidance. This self-centering action keeps the vehicle aligned on the track without the additional complexity of separate guidance magnets.

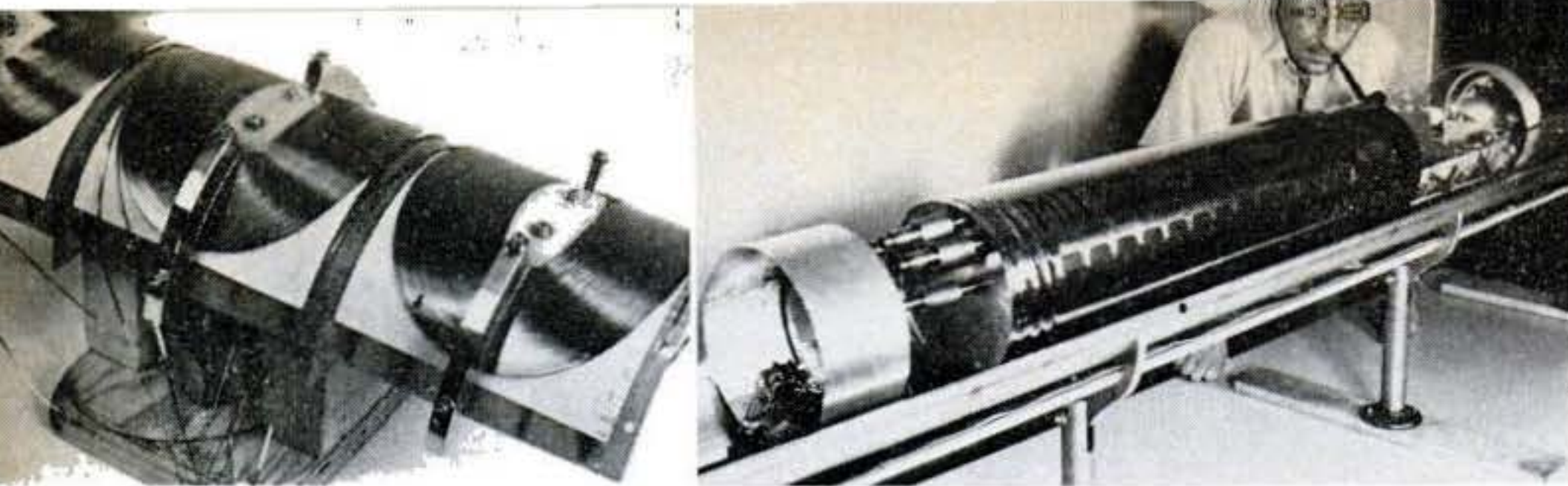
Getting Trains Off the Ground



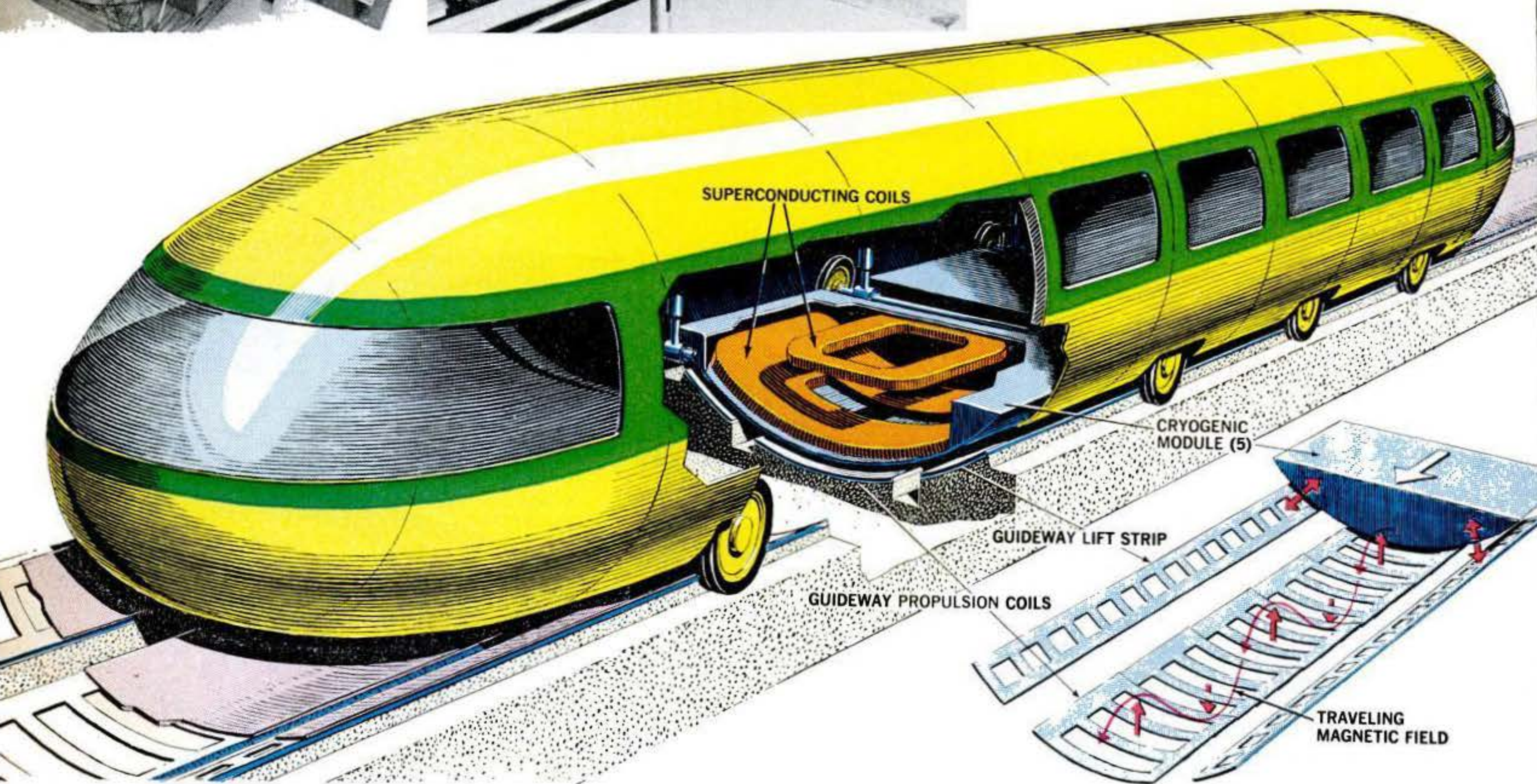
Single-sided linear induction motors on both sides of Romag induce fields in metal rails that both lift and propel vehicle. Sensors regulate voltages to maintain a fixed rail/motor gap. By changing frequency of three-phase power applied, vehicle moves horizontally. Rail shorting bars act like a motor rotor, providing thrust.

Romag test vehicle developed by Rohr Corp. in California first ran in 1971. A 12-passenger "people mover" like the one below was demonstrated on a 60-foot track at Transpo '72. Romag has unique LIMs that both suspend the vehicle (attractive levitation) and propel it. The concept can be applied to larger vehicles, says Rohr.



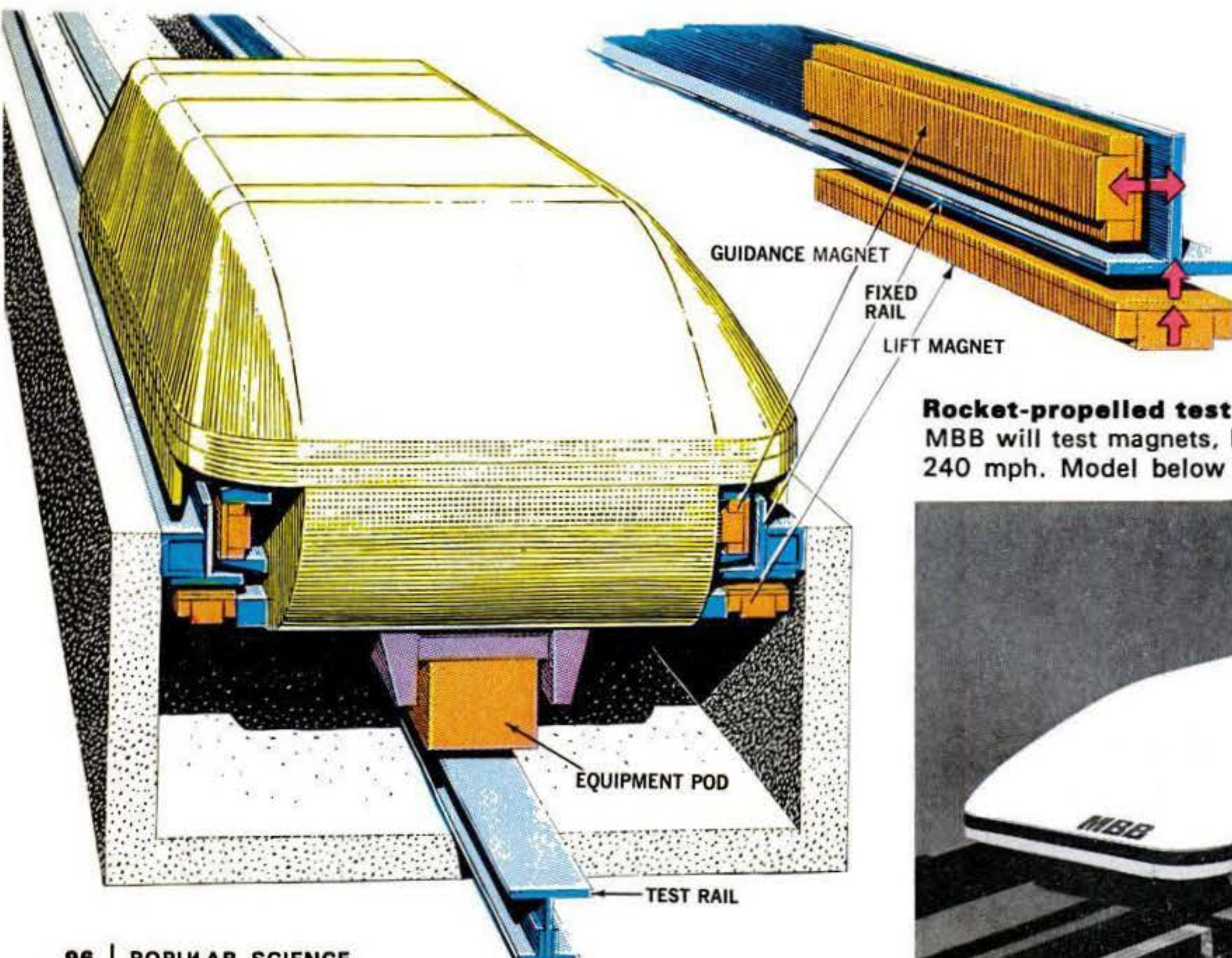


Scale model of M.I.T. Magneplane (left) is supported by saddle-shaped superconducting coils (far left) beneath model. Coils, readied here for an epoxy coating, lose their resistance in liquid helium, carry 200 amps.



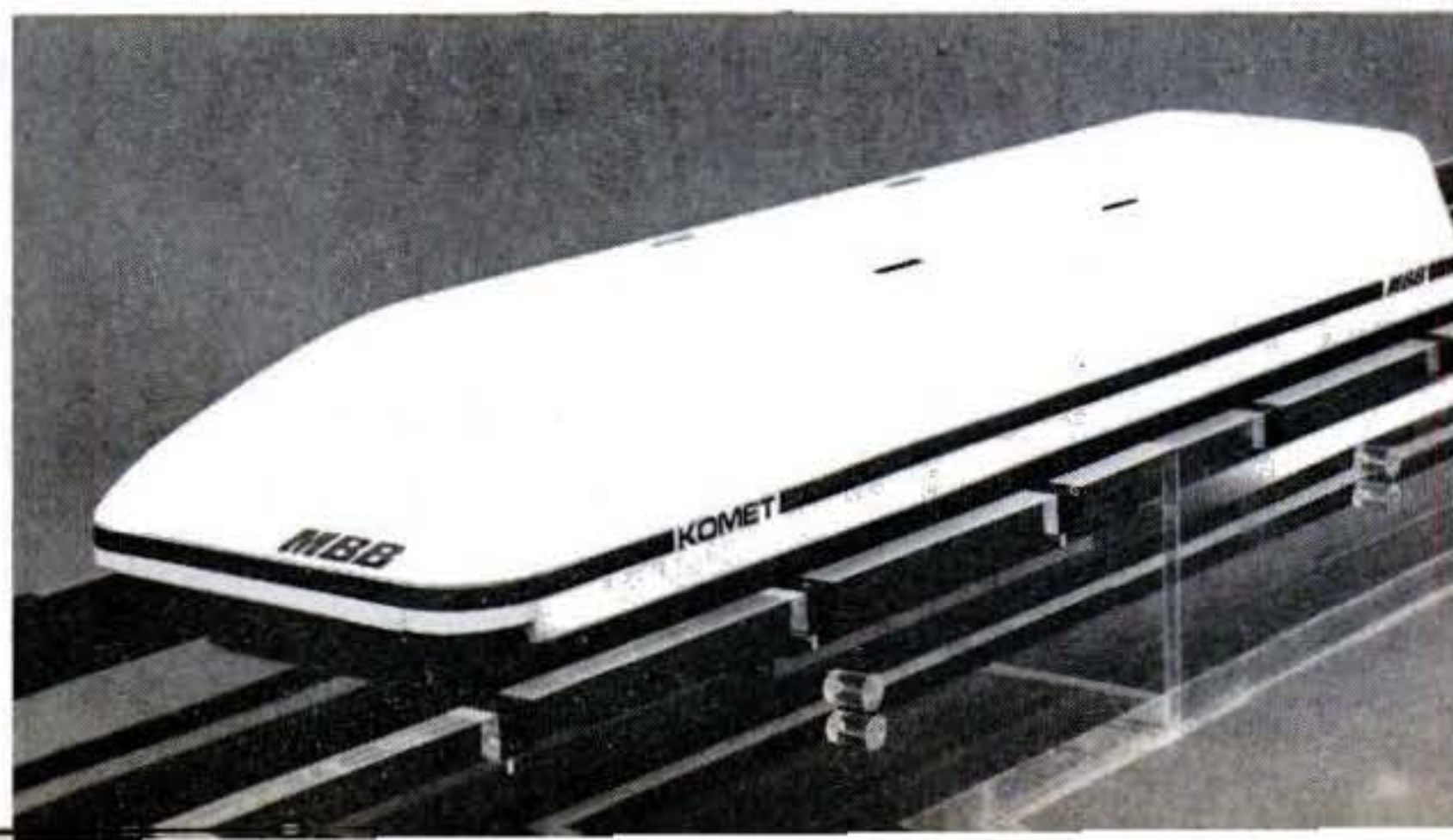
Passenger-sized Magneplane—not under construction—would contain five modules for superconducting coils. Larger bottom coils induce a repulsive levitation force in guideway lift strips. Smaller coils near the floor shield passengers from strong fields. Linear synchronous motor (LSM) would propel vehicle: Three-phase AC is fed to overlapping propulsion

coils as vehicle approaches. Detail shows the magnetic field from one phase of AC. Voltage is controlled so travelling fields interact with the powerful fields in the modules, pulling Magneplane along on a magnetic "surf." Wheels would retract as vehicle built up enough speed for levitation to develop, enabling it to bank in the guideway.



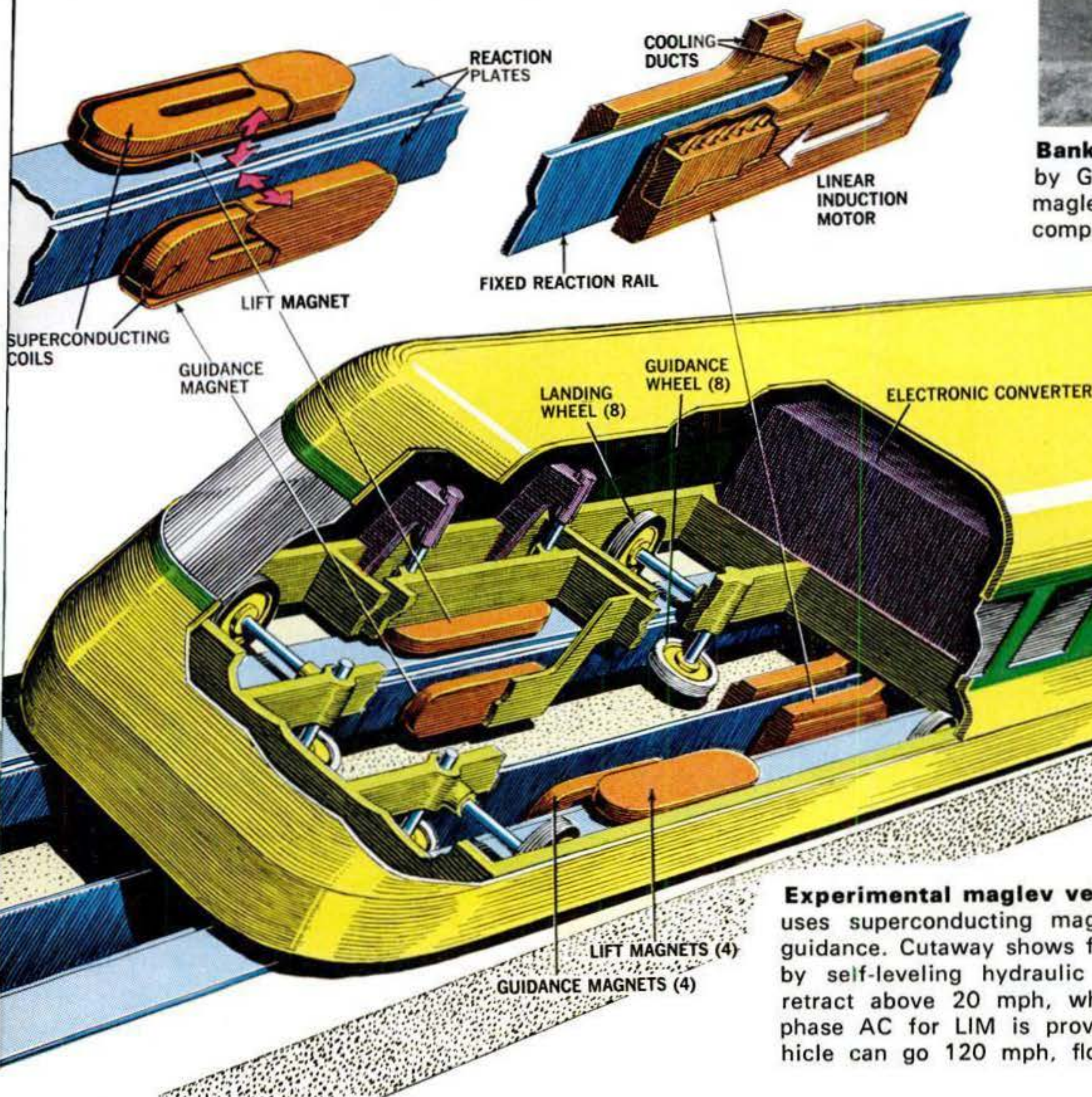
Attractive levitation suspends test car as on-board electromagnets are drawn to fixed rail. Guidance magnets work against vertical section of rails to keep car centered in test track. Inductive sensors next to each magnet determine the distance between magnets and rails. A liquid-fuel rocket accelerates unmanned test car, while equipment is evaluated against the flat rail.

Rocket-propelled test car under construction by Germany's MBB will test magnets, LIMs, guidance and control systems at 240 mph. Model below has streamlined design.



Superconducting magnets for levitation and guidance are repelled from continuous plates. Eddy currents induced in plates create opposing magnetic fields. Magnets must be moving above 20 mph.

Vehicle-mounted linear induction motor has double-sided primary straddling a fixed reaction rail. Interaction of the primary's field with currents induced in the rail thrusts the vehicle forward.



Banked 45-degree circular track built by Germany's Siemens will test 15-ton maglev vehicle below. The test track, now completed, is 300 yards across.

Experimental maglev vehicle being completed by Siemens uses superconducting magnets for repulsive levitation and guidance. Cutaway shows forward subframe, linked to vehicle by self-leveling hydraulic struts. Landing/guidance wheels retract above 20 mph, when magnets are effective. Three-phase AC for LIM is provided by solid-state converter. Vehicle can go 120 mph, floating 4 to 8 inches above track.

major highway program in favor of a \$1.3-billion modern transit program. Roughly half of these funds will be used to build a revenue-producing maglev line.

Maglev is one of the most promising of many new transportation vehicles being developed [PS, May '72]. Magnetically levitated vehicles are silent, nonpolluting, have no moving parts, and consume less energy than other high-speed systems.

Maglev variations. But as with other transportation systems, maglev vehicles will serve a variety of functions. JNR's high-speed maglev train, for example, will carry passengers between Tokyo and Osaka at nearly 300 mph. Slower 150-mph maglev trains under development elsewhere will carry passengers between suburbs, cities, and airports. Still slower-moving maglev vehicles will be used for personal rapid transit (PRT). These "people-mover" vehicles [PS, Nov. '71] will operate within cities or airport terminals to speed transportation.

One wheelless competitor to maglev is the tracked air-cushion ve-

hicle (TACV). These vehicles ride on a noisy cushion of air generated by on-board compressors. Although France remains committed to operating a TACV line, Britain early this year abandoned development of their Hovertrain after spending \$12 million.

In the U.S., the Federal Railroad Administration has committed some \$30 million to TACV research since 1967. As a result, Grumman Corp. has built a jet-propelled test TACV, and Rohr Corp. has a contract for a 60-passenger TACV. But the FRA's stress on TACV has resulted in a U. S. maglev program that's "rather sad" in comparison with other countries, as one maglev proponent puts it. Barely \$1 million has been funded for maglev research programs by the government.

Stanford Research Institute, one recipient of funds, has tested a magnetically levitated sled [Science Newsfront, PS, March '73]. Ford received a study contract. Although Rohr Corp. has built privately funded maglev vehicles (see drawing), and is developing a second-genera-

tion version, government support is a must to develop 300-mph city-to-city maglev lines.

Why invest billions in HSGT? Anyone traveling in the technologically advanced nations quickly discovers the reasons. Highways choked with cars moving at a crawl are becoming unbearable in many cities. Toronto residents actually halted construction of a highway cutting an ugly swath through their city, opting for a major urban transit program.

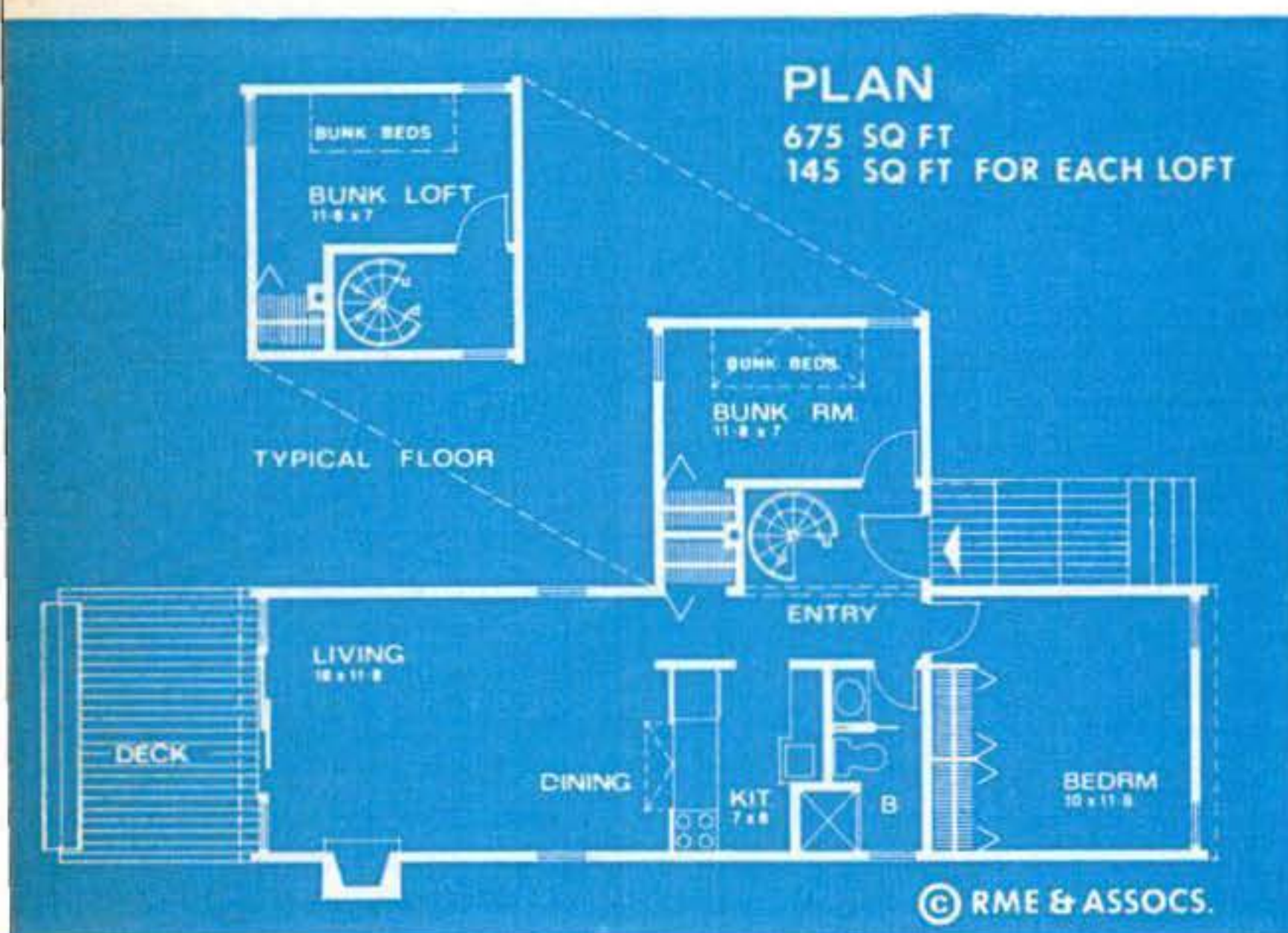
Airports and overcrowded air corridors are approaching a crisis state, too, as travelers become more affluent and develop a preference for jets. Yet airport-expansion plans now encounter stiff public opposition because of jet noise, pollution, and land use. Transportation experts point out that the 7.5 square miles of New York's Kennedy Airport would accommodate a 95-foot-wide guideway from Boston to Washington, D. C.

Maglev beats flying. Significantly, for distances up to 300 miles, HSGT can provide station-to-station

[\[Continued on page 133\]](#)



Bunk Tower Gives Every Room a View



You can order plans several ways

Quinipissa study plan (\$1) is spec sheet with additional information to help you decide if house fits your needs. V-PAC Guide (\$2) is catalog of all plans in series plus others. One set of blueprints, \$25; three sets, \$35. Check or money order to PS Vacation Plans Service, Box 622, Princeton, N.J. 08540.

For a ski chalet—or summer guests—stack up as many sleep lofts as needed. Last in our V-PAC Council series

A continuous stairway spirals up this tower from the entry vestibule. Identical bunk lofts are stacked beside it—one, two, three (or more) tall. Stacked sleep space makes special sense for vacation homes: The higher you go, the better the views you provide your guests. And the less site disruption for your foundation.

Since most leisure homes are built on a slope, you can tuck a partial basement under that glass-ended living room to expand the house function; use it as a game room, sauna, laundry, or storage area. Though the rest of this house has an insulated floor over crawl space, a flat site gives you the option of a full basement.

The architect calls this house the Quinipissa—an Indian name for “those who look out.” The top level of the tower is provided with additional window area to create an observation lounge. Imagine yourself greeting friends on the ski slopes with: “Meet us in the tower for drinks at four.”

• This is the tenth and final house in our monthly series, but we’ve asked architect Robert Martin Engelbrecht and the V-PAC Council to develop additional designs for publication next summer.—*Al Lees*



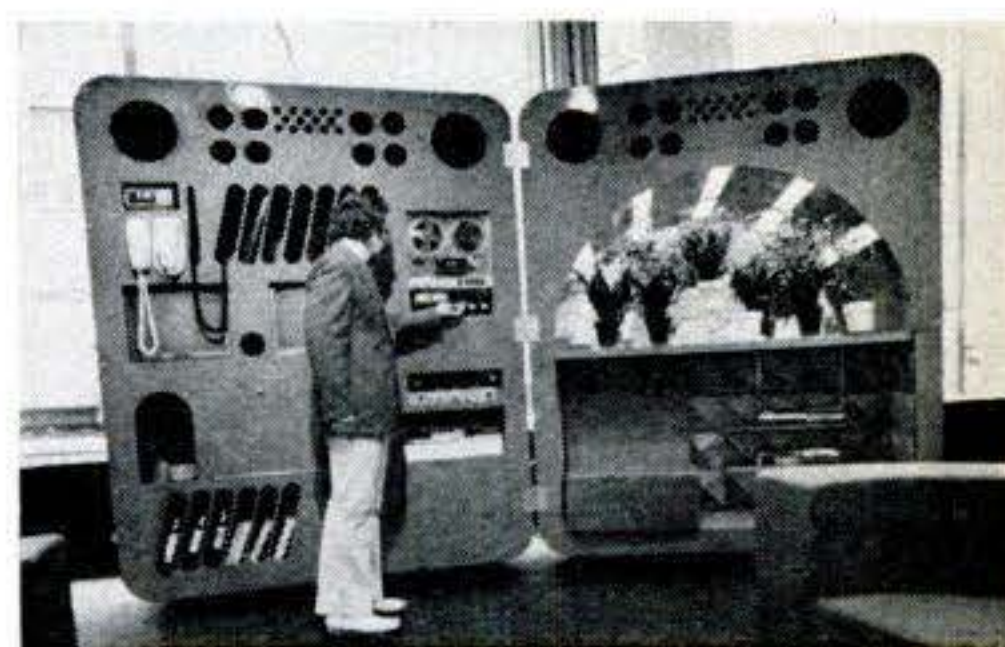
Out of a Suitcase: INSTANT ROOMS

Live out of a suitcase? Better (or worse) than that—you live *in* a suitcase with these “instant” rooms designed for an Owens-Corning Fiberglas exhibit forecasting possible trends in home furnishings in the next 10-15 years. The prototypes shown here—bedroom, dining room, and living room—are stored in giant suitcases and move on rollers.

The bedroom consists of a fold-down double bed, closet, drawers, and bookshelves. The dining unit includes a fold-out table with chairs, sink, refrigerator, bar, and storage space for dinnerware. The living room has a complete home-entertainment unit with TV, radio, turntable, tape recorder, video equipment, and telephone. Seating sections allow variations in the room arrangement. The three modules can combine to form a multipurpose room.—*Marilyn Dammerman*



“Suitcase” rooms are seven feet high, six feet wide, and five feet deep when closed. Each unit costs about \$2000 to make, not including communications equipment in the living room’s home-entertainment area.



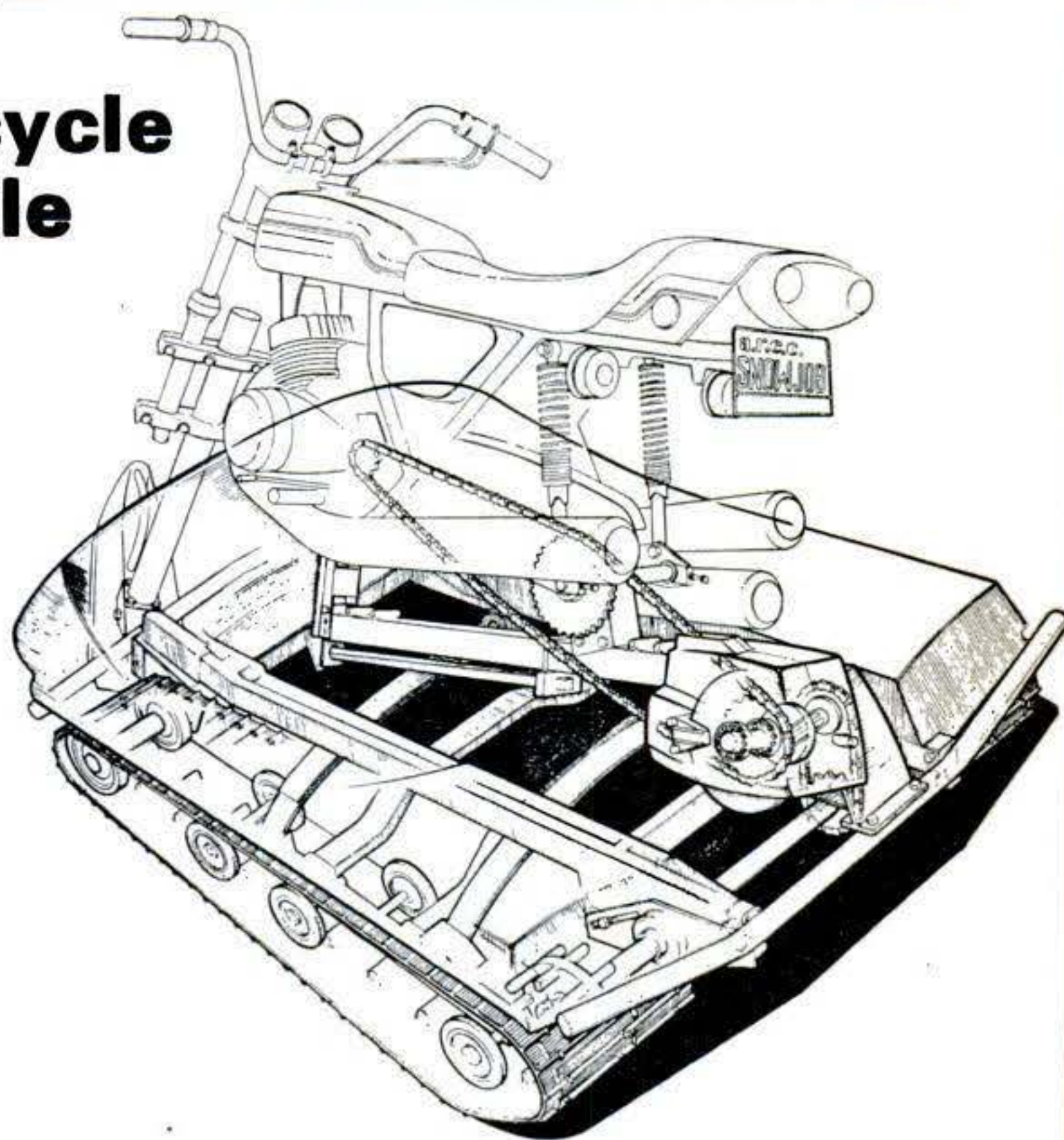
New Kit Turns Your Motorcycle into a Super-Hot Snowmobile



Tired of putting your motorcycle in cold storage when winter snows come? No need, with a Snow Job. This kit can turn almost any motorcycle into an exciting snowmobile that retains the superior handling characteristics of a bike. The hotter the bike, the hotter the snowmobile.

Actually, two separate kits are required. The basic kit consists of fiberglass body, running gear, tracks, tubular steel chassis, front and rear bumpers, swivel beam, final-drive assembly, fork extender, and front ski. Then you need an adapter set customized to your own bike.

The Snow Job uses your motorcycle’s suspension, and its own, too. So you can adjust handling to your own preference. Standard bike con-



trols are used to pilot the modified vehicle.

Conversion usually takes one evening, going either way. The kit is made by Advanced Recreational Equipment Corp., 645 National Ave., Mountainview, Calif. 94040. Price is \$778.—*Jim Davis*

20-PAGE SECTION



WINTER
WORKSHOP

HOME OFFICE tucks into a cube

You'd never suspect from its sleek teak exterior that this cabinet (roughly a 2½-ft. cube) blossoms like a Japanese paper flower into a complex, yet compact, desk with more features than the one in your office downtown. If paper work at home isn't your thing, consider using it as a crafts or electronics work center. By Ro Capotosto from Paul Wrablica's design.

For construction details, see page 106



From handsome sideboard (top left)

Every Home Needs a Desk

Choose from these three novel designs—
as widely varied in function as in ease of construction
—one will be right for your home



WALL DESK totes where it's needed

Designed like a piece of luggage, this stylish hardwood-and-Abecite desk lifts off the wall, has a brass handle for carrying. Use it on any wall—indoors or out—that will take a pair of picture hooks (they remain inconspicuously in place while the desk is elsewhere). It takes its own light along, so you can even mount it in a dim bedroom corner. Designed and built by Richard Sickler.



For construction details, see page 110



unit unfolds into a fully equipped desk at right, with its own file, seating, and typewriter storage built in.



PHONE DESK rolls to your bedside

This neat sideboard rolls from your bedroom wall to cantilever its sliding top across you—at proper height for consulting the Yellow Pages or taking notes while you phone. Beneath the top are storage wells for phone, directories, and portable TV. Shelves keep typewriter and tape recorder handy. Desk is ideal TV stand for bed-watching: roll to wherever viewing is best. Designed, built, and modeled by Gary Gerber, IDSA.

For construction details, see page 111





**WINTER
WORKSHOP**

New Life for a Pair

Whether you make them for decoration or functional play,



SEE-THROUGH BACKGAMMON BOARD

The ancient game of backgammon—a current rage again—looks great in modern dress. It's all Plexiglas, right down to the dice cups. Here's how to make it:

Cut all pieces and sand out saw marks with number-80 paper on a block. Study the sketch at right. All exposed edges should be polished to

YOUR PICK OF APPALACHIAN



The Appalachian-mountain dulcimer, known for its delicate, charming sound and simple strumming, is as easy to make as it is to play. Unlike other instruments that have evolved into formal patterns, the dulcimer is still designed largely by its builder. Wood for the body and fretboard should be straight-grained, clear, and quarter-sawed.

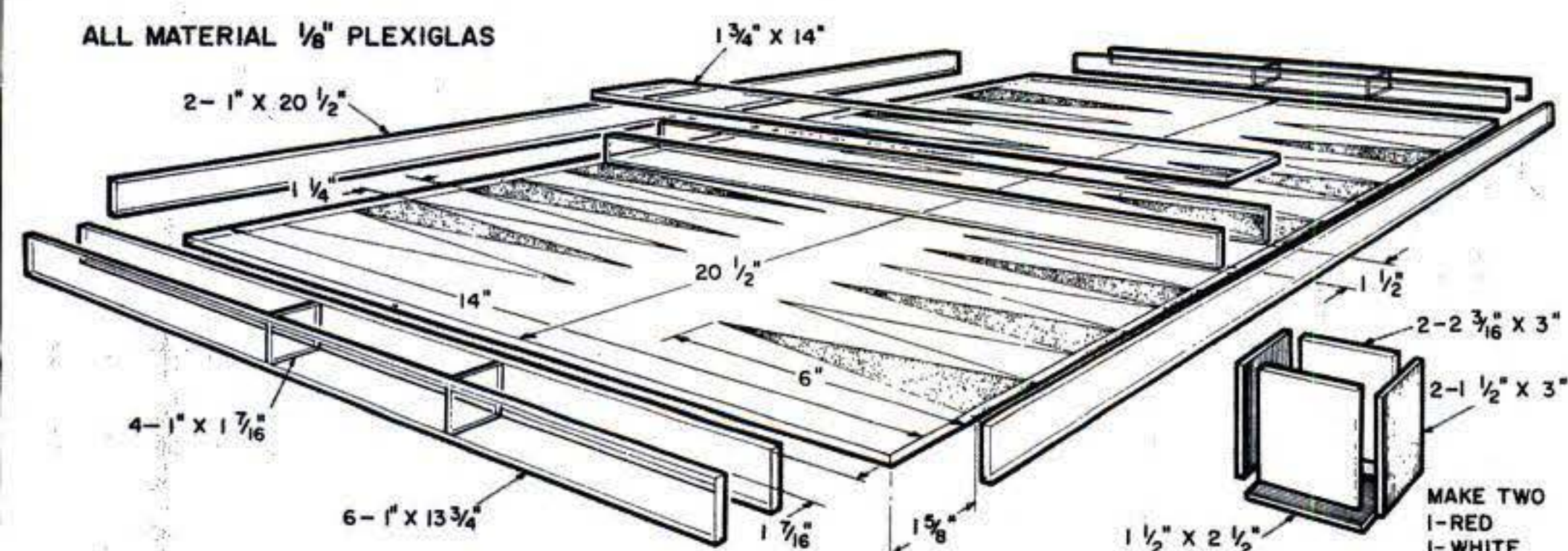
The pattern and mold. Fold a large piece of paper in half lengthwise and mark the fretboard length along the fold with two lines extending half the desired fretboard width. Connect the ends of these marks with a graceful, curved line for the final body shape. That shape is up to you. The traditional patterns here, by Appalachian craftsmen David Hoffman (walnut tear-drop) and Jene Hughes (spruce hourglass), were formed by bending a narrow slat (already cut for use as one of the body sides) and tracing its curve.

Cut through both halves of the paper and unfold your pattern. Transfer the shape to a flat board and use blocks of wood and angle

of Old Favorites

here are two fun items enjoying a mod revival

ALL MATERIAL $\frac{1}{8}$ " PLEXIGLAS



transparency. To do this, resand with 220 paper, then switch to 320 waterproof paper used wet. After that, turn to 400 paper—also used wet—and finally polish with automotive rubbing compound on a rag.

Now lay out the arrows on the bottom of base piece. Draw them right on the masking sheet. Use an X-acto

or razor blade to cut out the red arrows. Peel off the mask for the red arrows and spray the exposed surface with an acrylic lacquer. Four or five light coats 20 minutes apart will do the trick. Tape the edges of the base to mask from overspray.

Now cut and strip the masking from the white arrows. Spray as be-

fore. Give the red arrows a coat or two of white, too.

After the lacquer has dried a good 24 hours, cement the board together. Use masking tape to hold the parts while you apply a solvent cement on all butt joints. Use the same procedure to cement up the dice cups—simple 2"-by-3"-by-3" boxes. When assembly is complete, wash the board with detergent and warm water.

Since our board is for display, we've made no provision for foldup storage. You buy the red and white "men." A checkers set won't do since it has only 12 of each color. Backgammon calls for 15 each.

Need further instructions? A plans sheet including a full-size layout of the arrows is available for 50¢. Send to: Projects of Plexiglas, Box 14619, Philadelphia, Pa. 19134, and ask for No. 52. **PS**

DULCIMERS

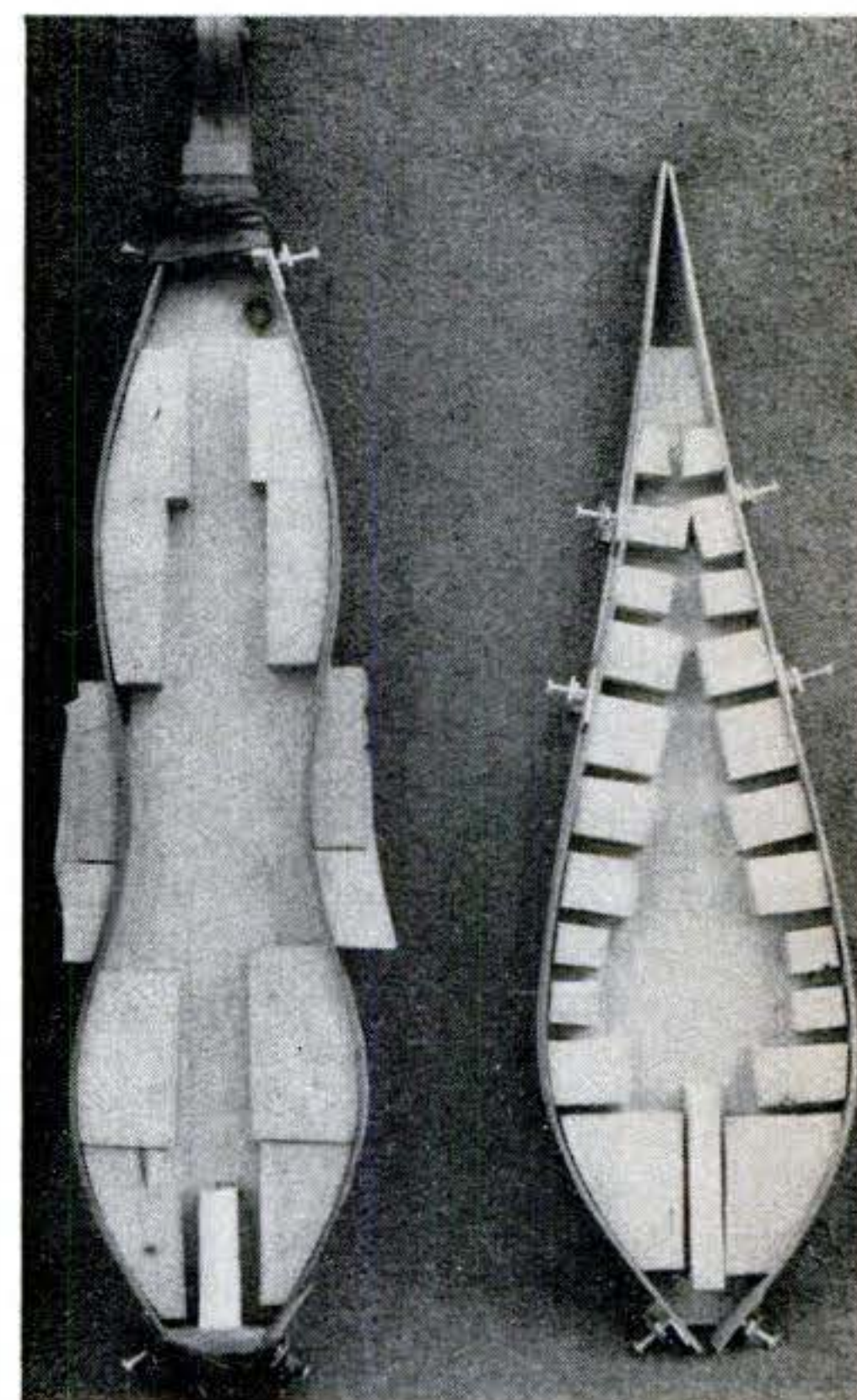
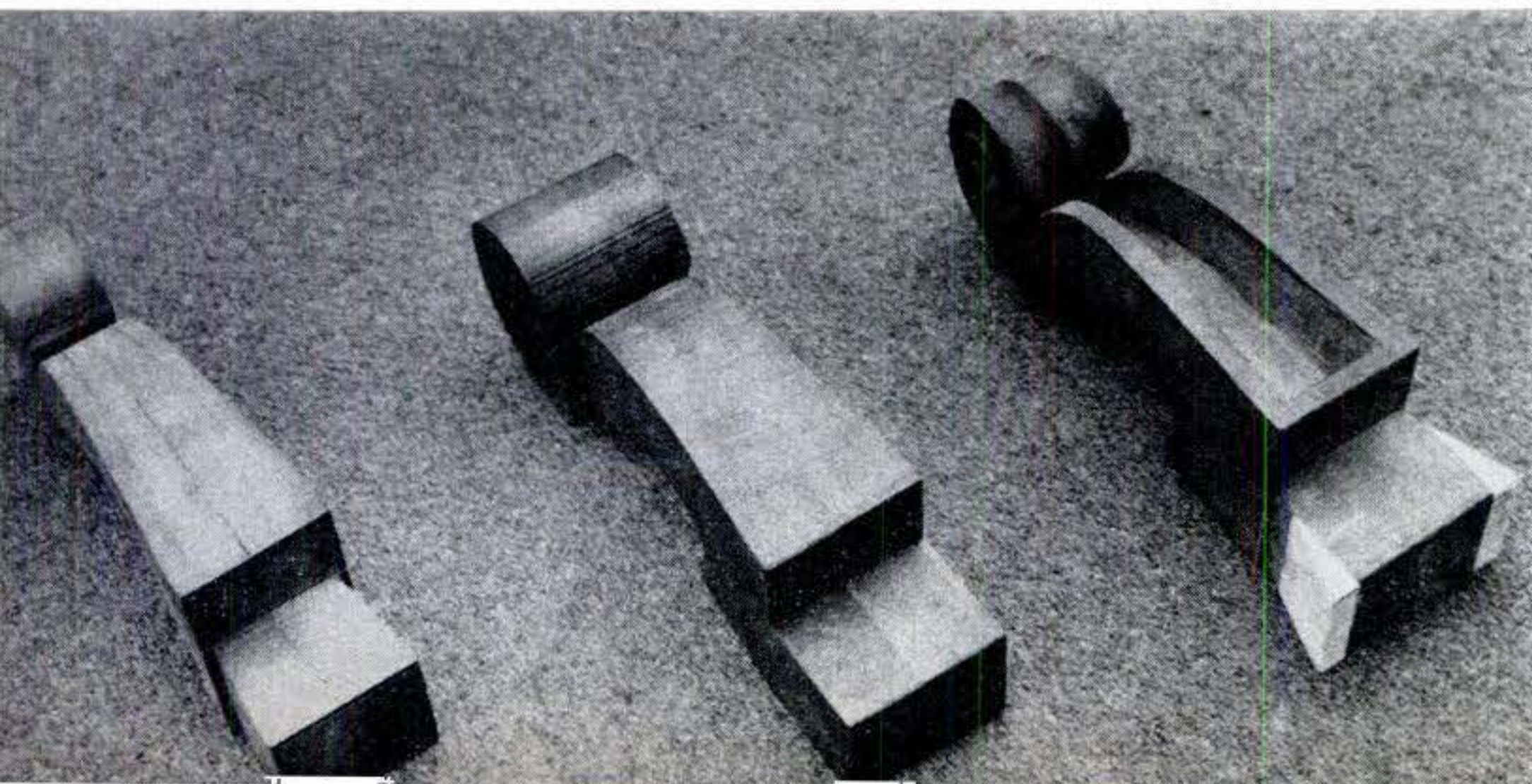
brackets with bolts to complete the mold. At points where the sides curve in, align the blocks with the edge of the pattern; where the sides curve out, set in the blocks to allow for the thickness of the side slats.

Fashioning the peghead. It may be either plain or carved, as shown. The part of the peghead that is to be glued inside the dulcimer must be notched and tapered so the body sides join flush with the peghead's exposed portion. The final shape here

must match the corresponding part of the mold, less the thickness of the sides. If necessary, use scrap wood to increase the angle. Complete the peghead by drilling and tapering holes for the tuning pegs.

Tail block and sides. The tail block is fitted by again using the mold to determine the shape. It should be made $\frac{1}{16}$ " lower than the width of the sides so that in the final assembly there will be an open-

Continued



Mold for curved sides is made of blocks of wood held in place with bolts and angle brackets. Build it on a base of pine or plywood. Scroll peghead is a challenge in wood carving. Block at far left is for a plain scroll. Center block is for a carved scroll like the one nearly completed beside it.

The dulcimer is still largely designed by its builder. Each one has

ing between it and the top through which the sound may escape.

The side slats must be clamped together and carefully planed so that both edges are straight and parallel. Then they should be weighted and submersed in water for 12 hours and clamped in the mold for a full day. Square and cut off excess at the peghead end and test the head and tail blocks for fit. Adjust as necessary for a tight joint and, using wrappings or inner-tube rubber for clamps, glue sides to peghead and tail block upside down. Since the tail block is smaller, it must be shimmed up to be flush with the upper edge of the sides as they rest in the mold. Trim excess length from the sides after glue has set.

The bottom. Check that the side assembly has not twisted in the mold by sighting a straight line from head to tail. The bottom piece is marked by holding it in place and tracing around the sides from underneath. Saw out the piece, staying to the outside of the lines and glue in place, again using wrapping of rubber for clamps. When dry, remove it from the mold and reinforce with small triangular blocks of scrap pine and bottom braces as shown.

The fretboard. This is the most critical step in building a playable instrument. Plane the top and bottom surfaces as flat as possible and complete the flattening by sanding on several sheets of sandpaper, ce-

mented end-to-end on a flat board. A twisted fretboard or one bowed up in the middle will render the instrument unplayable, while a slight downward bow in the middle is acceptable. Cut out the strum hollow, inset the endpiece, and drive the end pins into deep but small starter holes. The underside of the board must be hollowed out from within 1" of the nut to within 1" of the strum hollow, about two-thirds of the thickness and 3/8" in from the sides. This increases the resonance greatly.

Shape the nut and cut a notch for it so that 3/16" rises above the surface of the neck. Starting from the notch's edge, mark the fret spacing.

Use a fine-bladed saw to cut kerfs for the frets, and drive the barbed edge of the fret wire into the slot. Each fret should be left a little long, filed off, then sanded with emery cloth to insure smoothness.

The top. This is marked to fit the bottom assembly and sawed, leaving some excess to trim later. The sound holes (any shape, attractively placed) are sawed out and an opening is cut to match the hollow underside of the fretboard. This opening is broken to allow for the cross brace. Align the top and fretboard neck on the bottom assembly and lightly mark the position on the top. Apply glue to the fretboard, and join to the top with small wire brads from the underside.

Final assembly. Glue together top and bottom assemblies, using

clamps. Next, glue the nut in place and file shallow grooves for the strings. Fit the tuning pegs in their holes, wind on one of the double melody strings, and make a test bridge—shaped like the one in the plans but not to be notched in place. Hold it between the strum hollow and tail while depressing the string at different frets (just left of the fret with the peghead to your left) to check for buzzing sound. If the string buzzes, the test bridge is too low. Lower the string (from both ends, keeping the tail end higher) as far as possible without causing buzzes.

Once the final string height is determined, enlist the aid of a recently tuned piano or a friend with a good ear for pitch. The open (unfretted) string must sound one octave higher when fretted at the eighth fret (when singing *do re mi fa sol la ti do*, the two *dos* are one octave apart—the distance between any eight white keys on a piano). If the note at the eighth fret sounds too high, move the test bridge toward the tail, and vice versa. Repeat this process with the bass string (this end of the notch will be closer to the tail).

Once well-tuned octaves are found, mark the location and saw the notch for the permanent bridge, which must be sized so the string height is identical to that of the test bridge used. Sand the dulcimer and finish with gunstock oil (not linseed) and cabinetmaker's wax. PS

As easy to play as to make

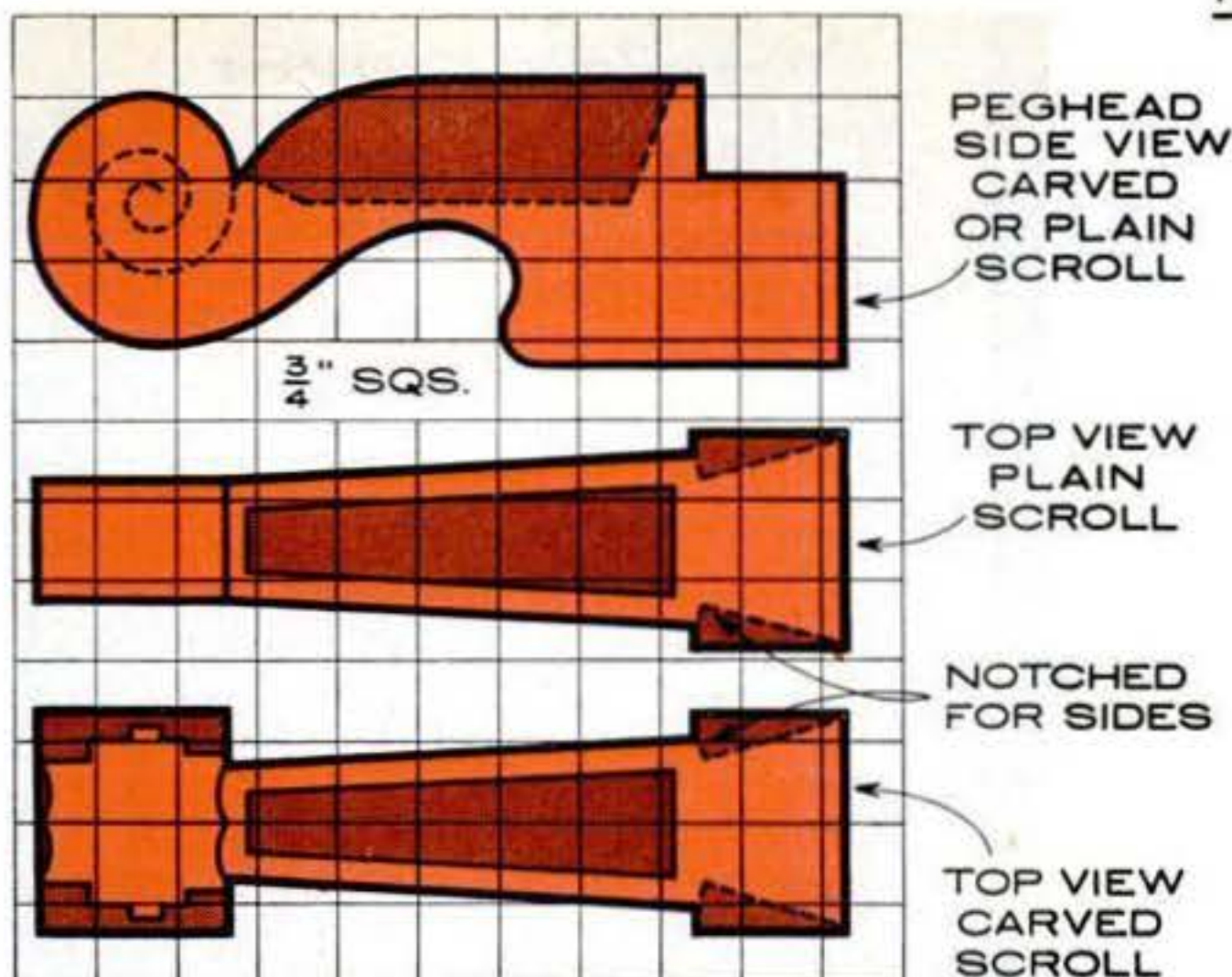
Place dulcimer across your lap with the peghead to your left. A noting stick is used to depress the double melody strings (the other two just drone). Don't lift this noter to change notes—slide it while your right hand strums with a quill, thin wire, or piece of plastic jug. To find the most resonant notes for tuning, hum up and down into a sound hole until you feel the dulcimer ring and vibrate. There are usually two different notes that will produce this, so tune the bass string farthest away from you to one of these notes, taking care not to tighten to breaking point. Using that note as *do* of the musical scale, sing, "*do re mi fa sol*," and tune the middle string to *sol*. Complete the scale, "*sol la ti do*," and tune both of the melody strings to the high *do*.

This scale can now be played from the open string by using the noter on each fret in order, skipping only the sixth fret (which is used when a dark, minor sound is desired). The right hand strums away from the body with the words of the song, and a quick return strum adds variety. Try using the return strum every other time. The art of dulcimer playing is in knowing the many tuning methods: Try lowering the middle string from *sol* to *fa*, and fretting the melody string at the third fret to produce *do*, for example. Instruction books give other tunings. Dulcimers can be picked like banjos, strummed like guitars, bowed like fiddles.—Jene Hughes

Violin-style carved scroll with hardwood tuning pegs is more traditional, but the guitar-style peghead is easier to make, and the metal tuning keys work much more smoothly.

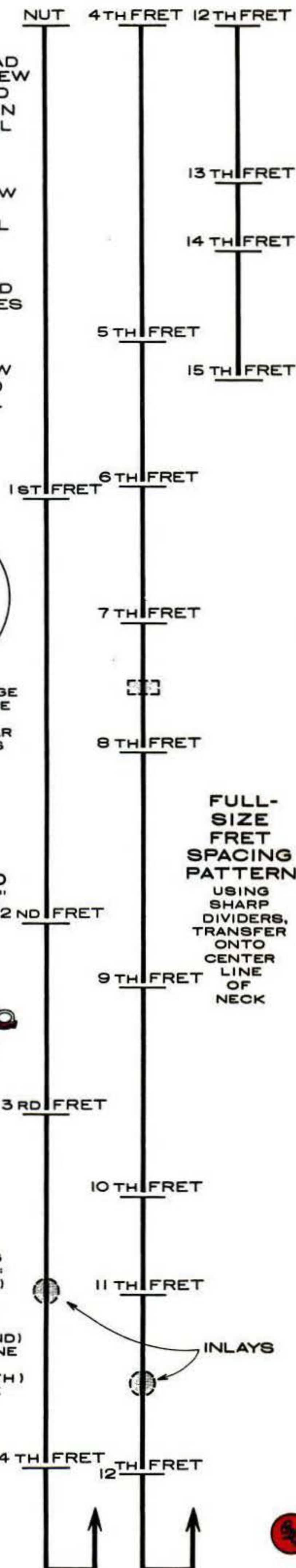
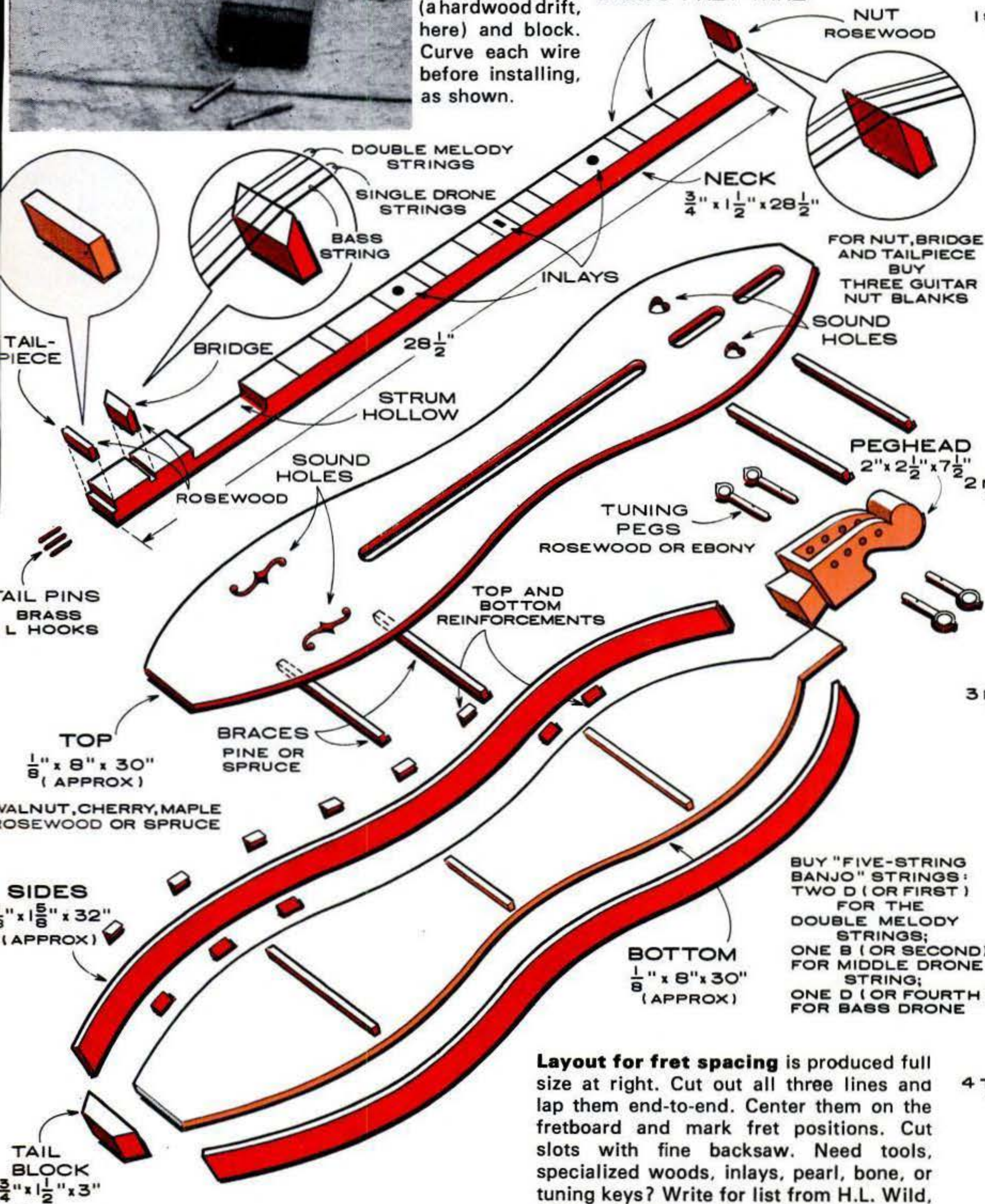


its own distinctive voice



Tap frets into kerfs with mallet (a hardwood drift, here) and block. Curve each wire before installing, as shown.

FRETS CUT FROM 30" LENGTH OF BANJO FRET WIRE



FULL-SIZE FRET SPACING PATTERN
USING SHARP DIVIDERS, TRANSFER ONTO CENTER LINE OF NECK

BUY "FIVE-STRING BANJO" STRINGS: TWO D (OR FIRST) FOR THE DOUBLE MELODY STRINGS; ONE B (OR SECOND) FOR MIDDLE DRONE STRING; ONE D (OR FOURTH) FOR BASS DRONE

Layout for fret spacing is produced full size at right. Cut out all three lines and lap them end-to-end. Center them on the fretboard and mark fret positions. Cut slots with fine backsaw. Need tools, specialized woods, inlays, pearl, bone, or tuning keys? Write for list from H.L. Wild, 510 E. 11th St., N.Y., N.Y. 10009.



WINTER WORKSHOP

By **ROSARIO CAPOTOSTO**
From a design by Paul Wrablica

PHOTOS BY THE AUTHOR
DRAWINGS BY CARL DE GROOTE



Compact, easy on the eyes, and chock-full of function, this camouflaged office could be just what you need at home. The piece is handsome enough to warrant a place of prominence in any setting—living room, den, or master bedroom. And if paperwork isn't your thing, it makes a great hobby or electronics bench.

Salient features include the telescoping cubbyhole section, demonstrated at left . . . a sturdy drop-leaf typing table . . . a sliding work surface that opens to reveal a legal-size file (your typewriter parks under the file well) . . . a self-storing desk chair that tucks beneath a small-

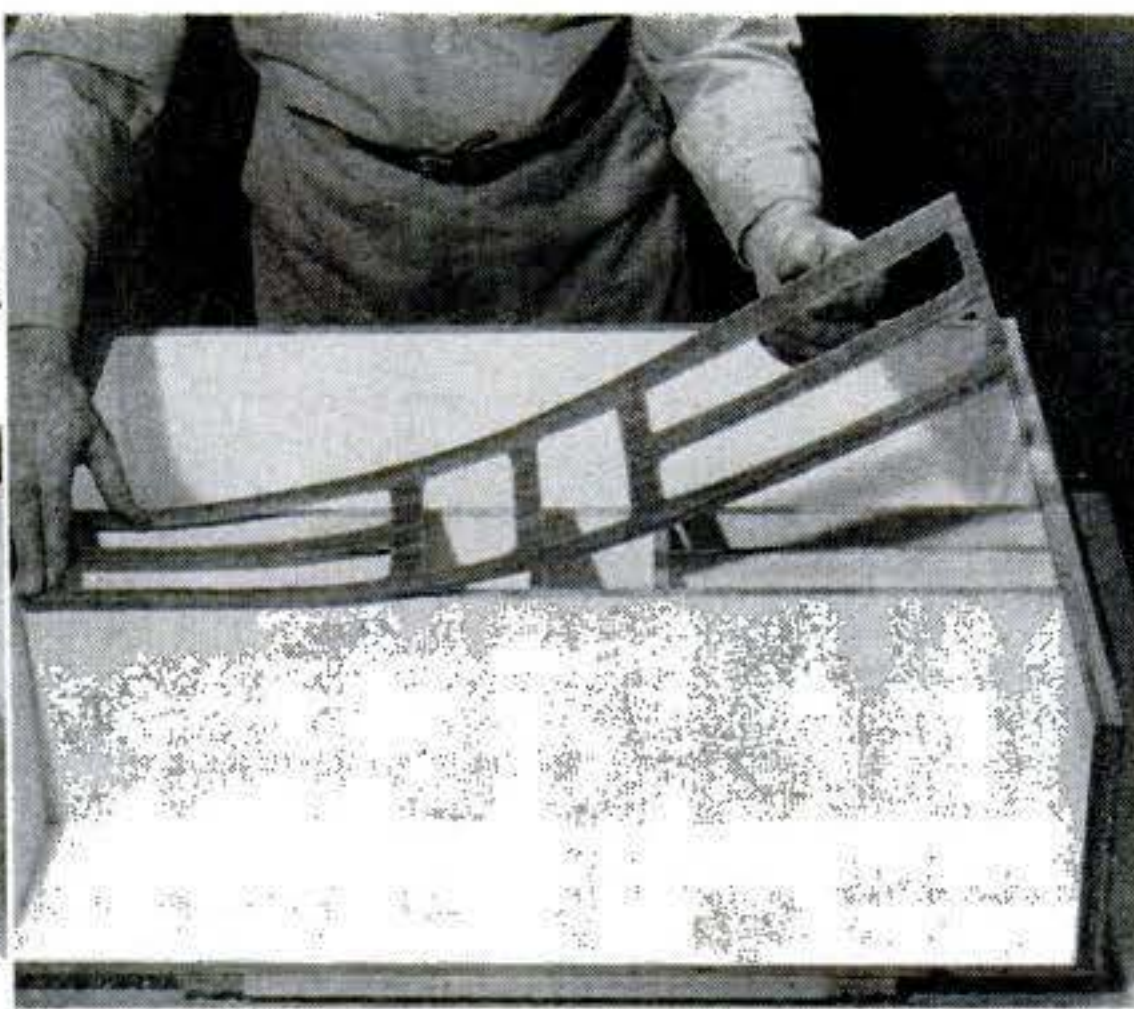
items drawer. Even the space within this roll-out seat offers valuable storage (of phone directories—or back issues of PS)—and you can turn a recess at the back of the knee-well into a rack for current magazines, as shown in the construction details, next page. Both seat and cabinet have casters for mobility.

One other plus: If you need to clear away top-surface clutter quickly—for unexpected callers, say—you can sweep it into the well below the cubbyholes and close the unit back into a handsome cube before your wife has answered the doorbell.

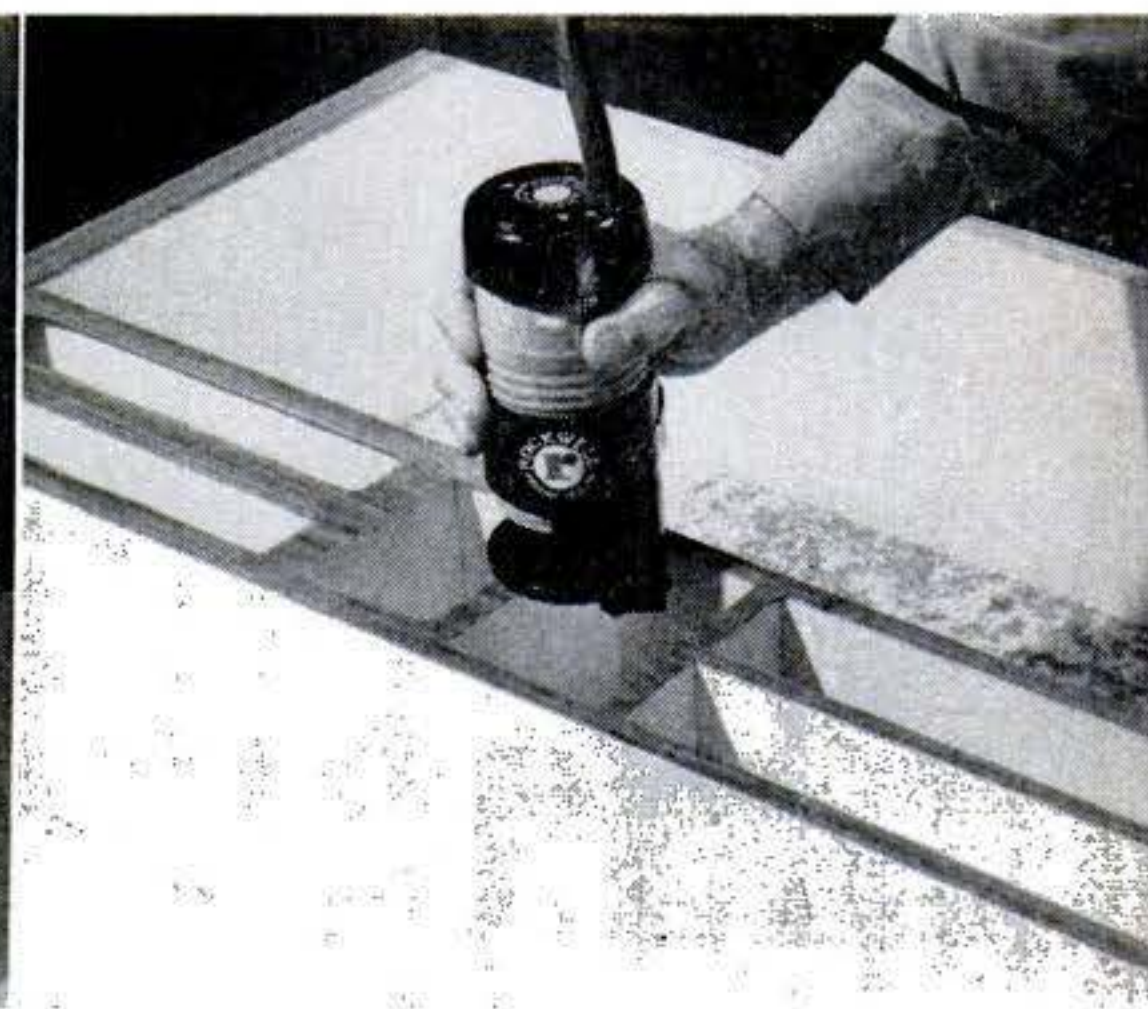
Basic construction is of 3/4" fir plywood, surfaced with 1/32" plastic laminate (we chose teak and white—check the striking effect in our color pages). We went this route (over hardwood-veneer plywood) for economy; the per-square-foot differential is better than two to one. Also favoring the laminate: It permits use



Plastic laminate to mask edges of lift-up shelving is easiest to apply in one piece, instead of hard-to-fit separate strips.



Apply pierced sheet carefully from one end after coating back (and shelf edges) with contact cement; this prevents bulges.

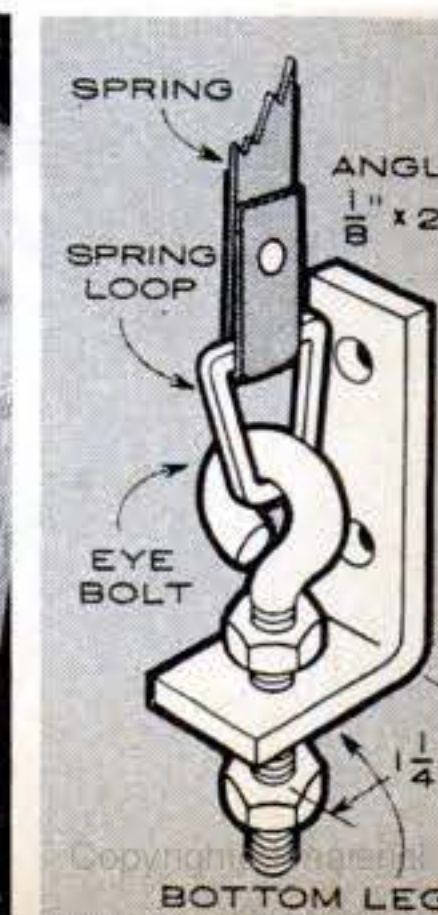
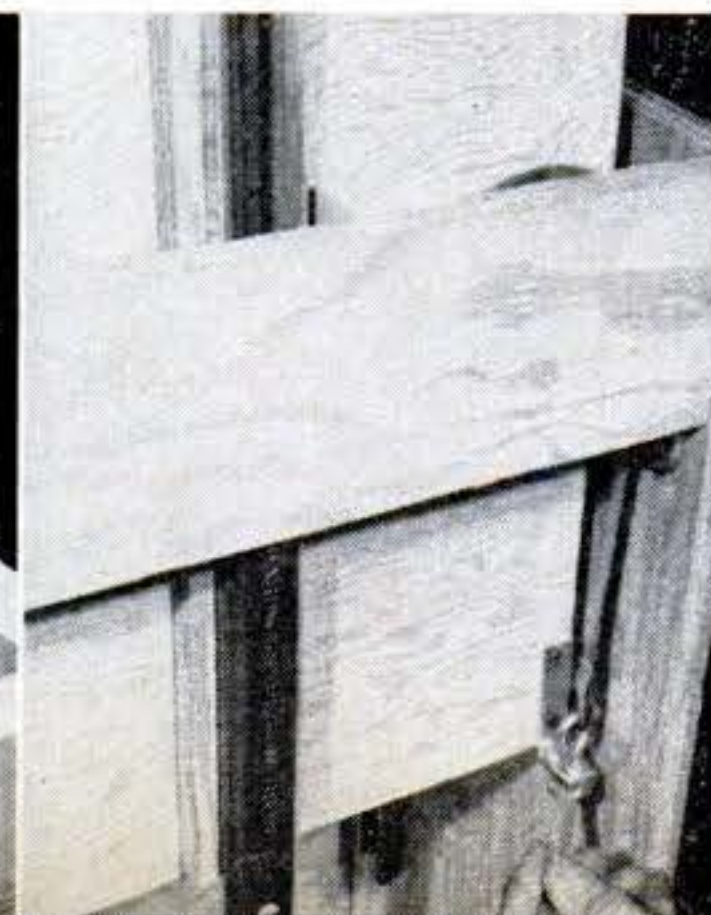
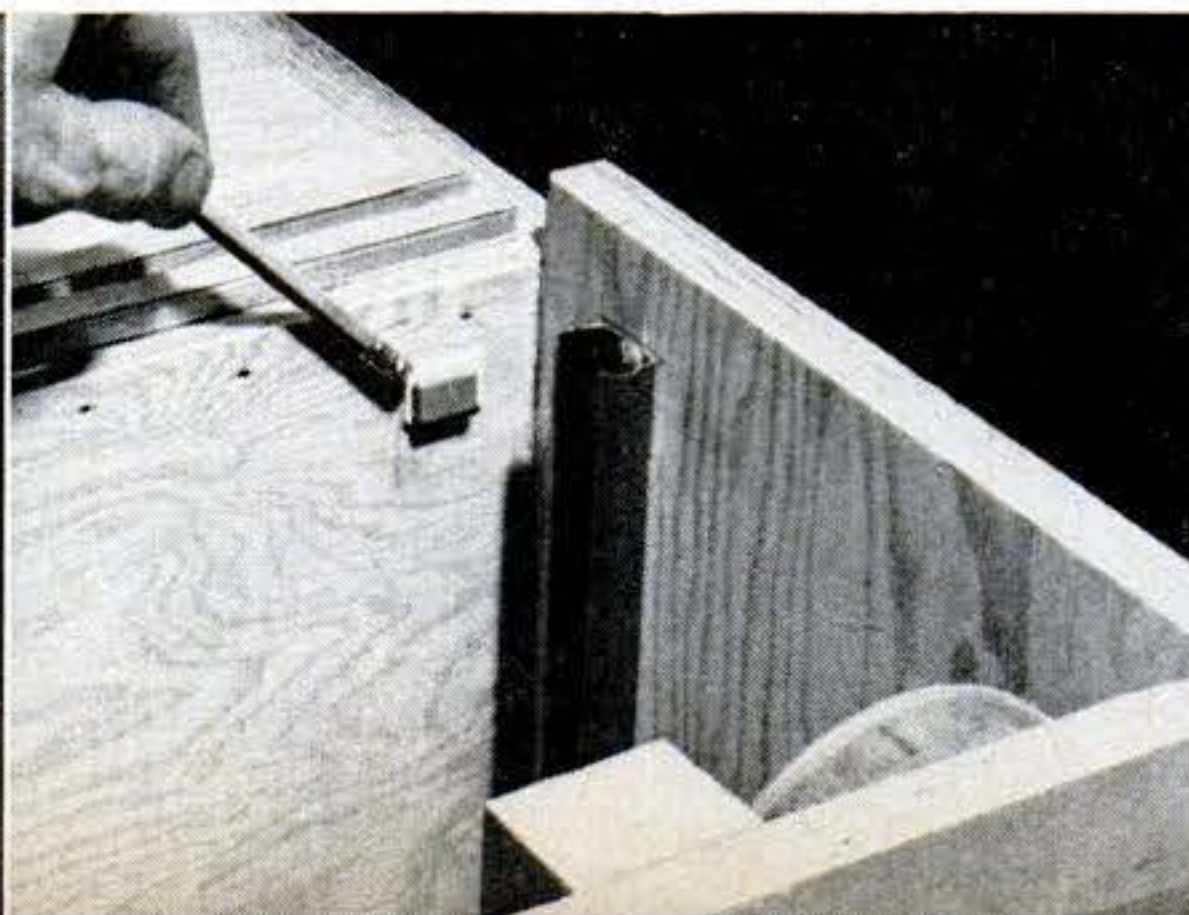
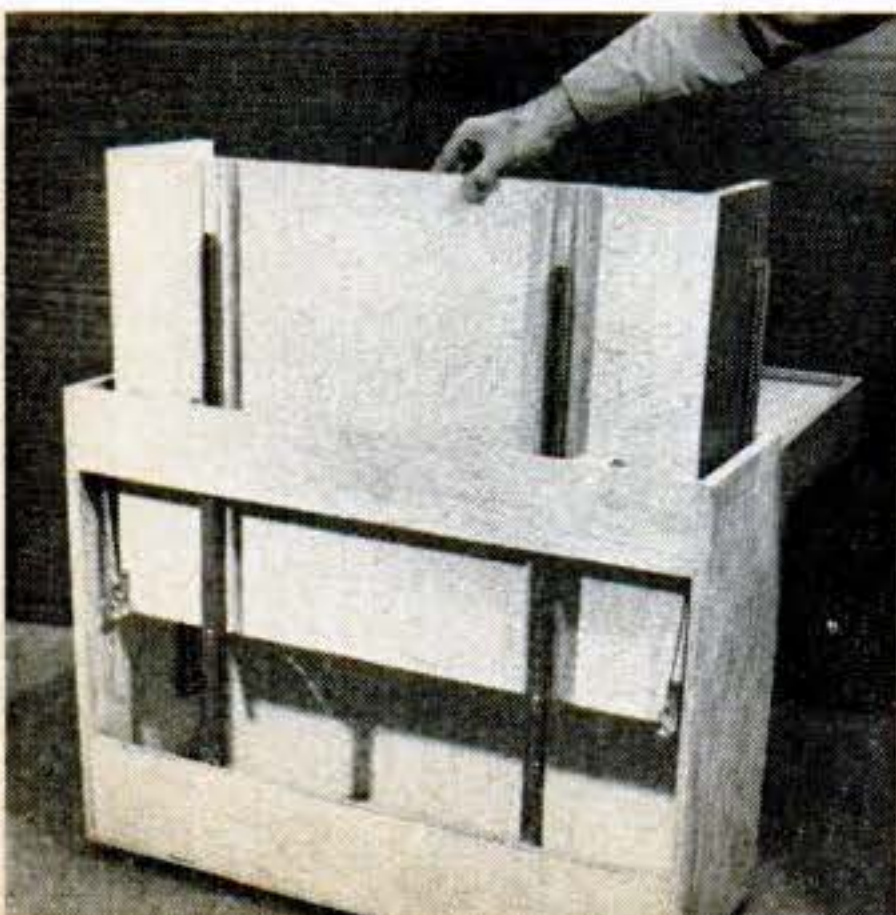


Trim all edges flush with bevel cutter, once cement has set. Corners that tool can't reach are squared with bastard file.

Test up-and-down travel with springs connected and make slight adjustments with shim washers under tracks if needed.

Flat-surfaced nylon tack glide, located on partition in line with front edge of shelf wall, helps control forward lean.

Eyebolt through angle bracket anchors spring loop to shelf unit at each side. Double nuts give you tension adjustment.



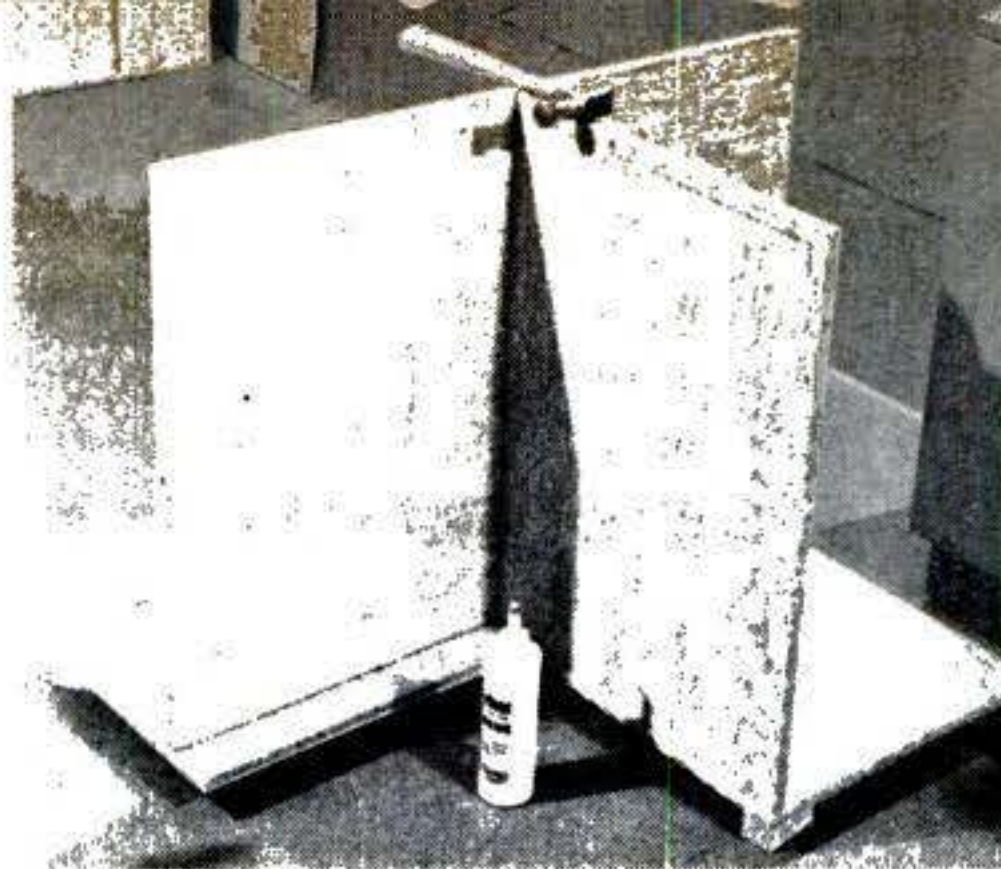
SPRING
ANGL 1" x 2"
SPRING LOOP
EYE BOLT
BOTTOM LEG

Cube

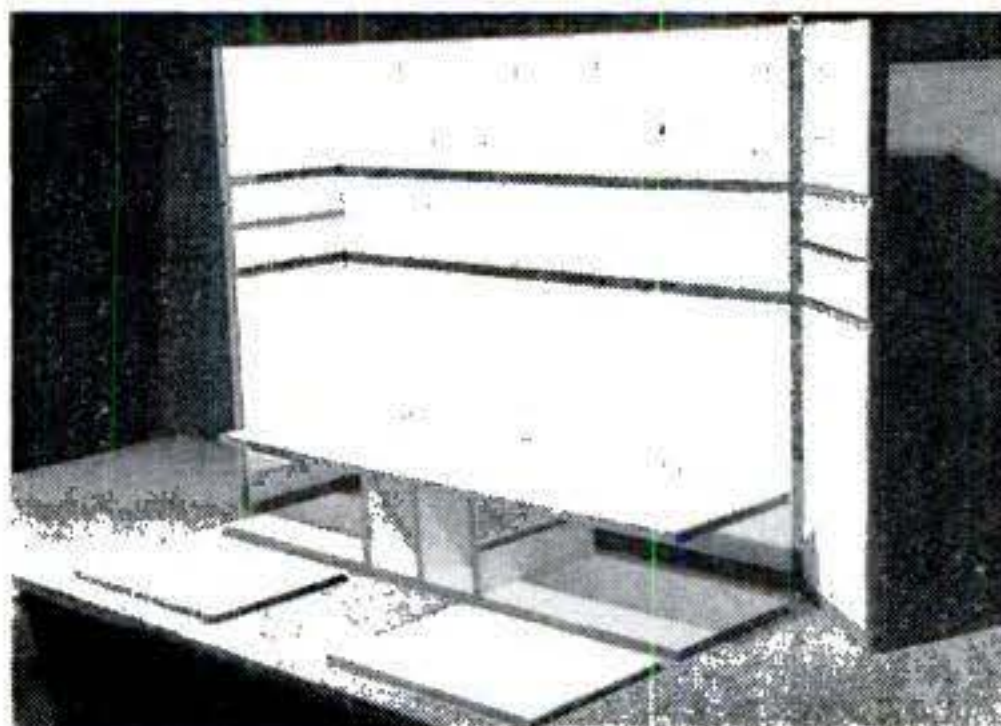
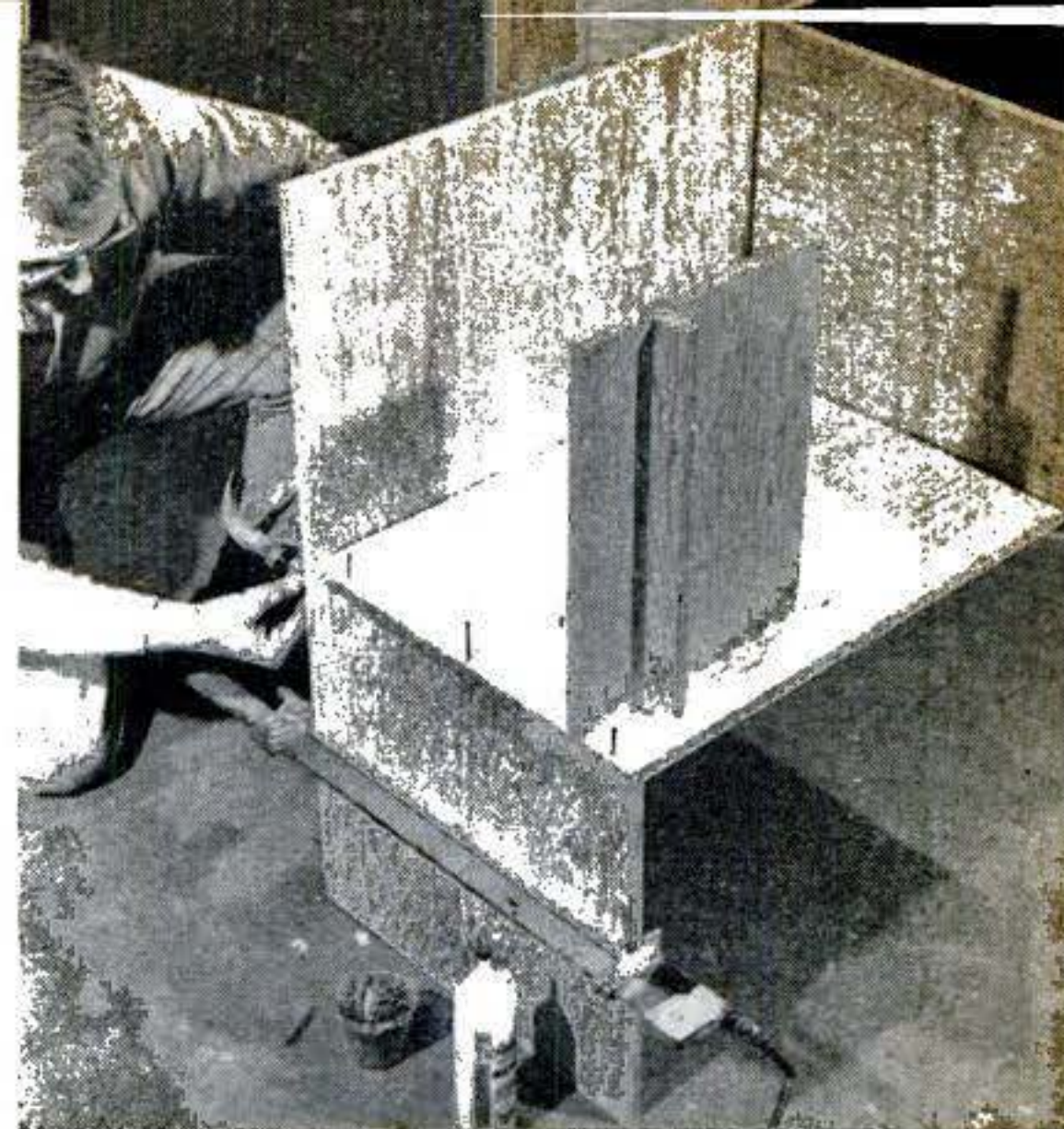
of butt-joint construction, whereas fussy miter-and-spline joints would be required with veneer panels to achieve decent corner match. As a final bonus, maintenance is nil—no finishing, no waxing, and smudges wipe away with a moist cloth.

New lift-up mechanism. The mechanism that makes our lift-up shelving practical is unique in its simplicity and efficiency. (You'll want to file the idea away for use in other projects as well.) This unit could weigh over 50 pounds when loaded, yet very little effort is required to lift or depress it. I got the basic cabinet sketch from PS (commissioned from a designer) with the lift system unresolved. This proved quite a challenge because ready-made hardware suitable for the purpose simply doesn't exist. After much research and experiment a solution finally evolved: a combination of

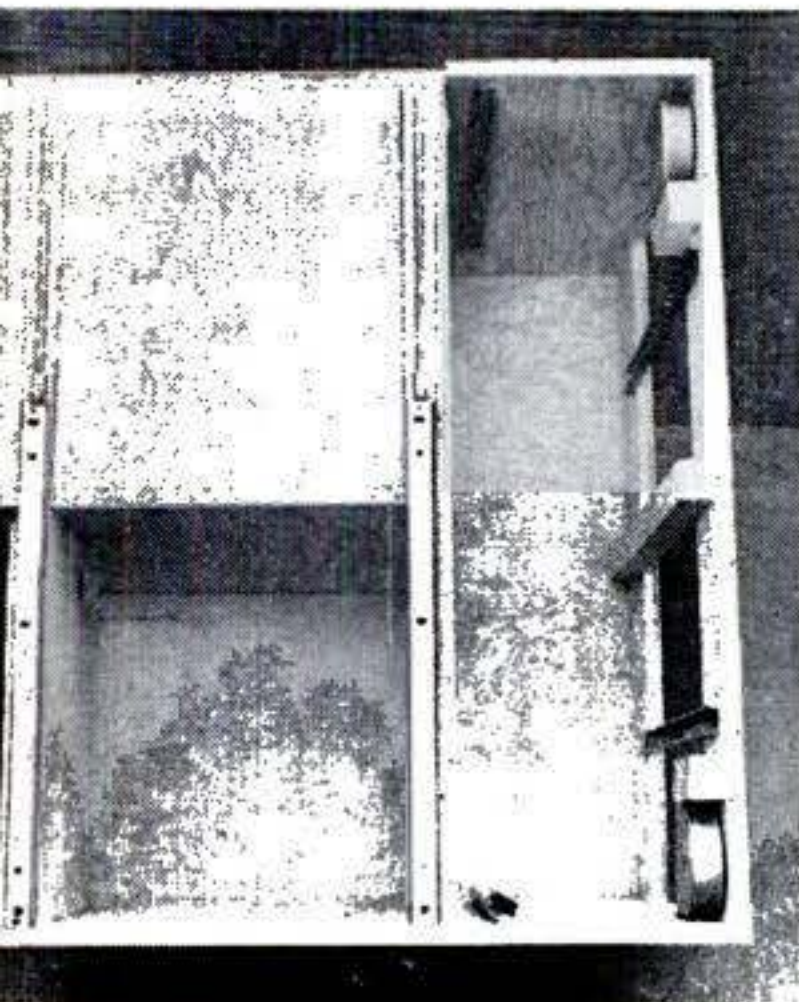
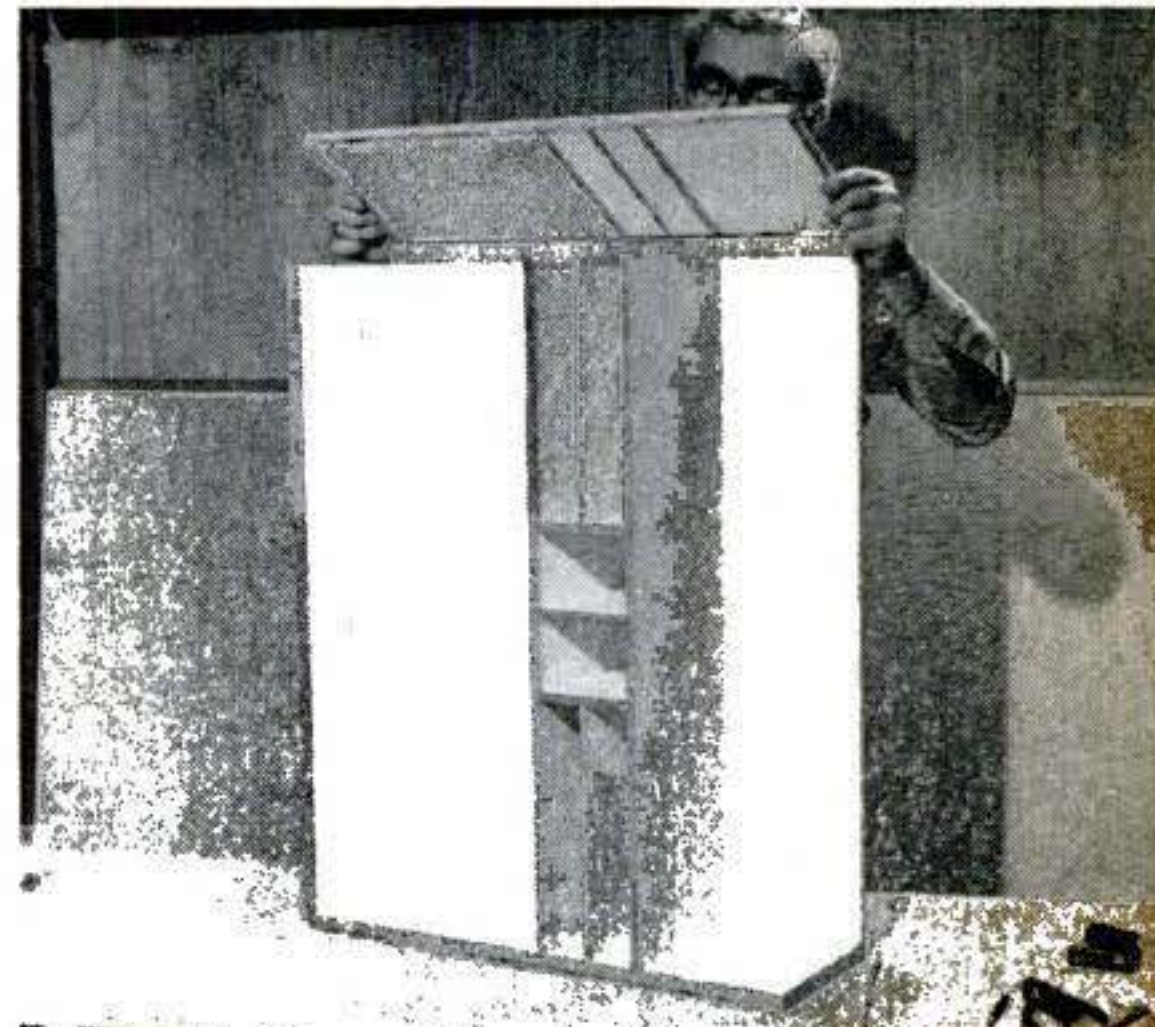
Continued



Start assembly of carcass with central T, then add L-shaped bottom panel and short upright across back edge. In photo at right, unit is tipped up onto its left side so as to nail into clamped-in-place top through both partitions of basic T.

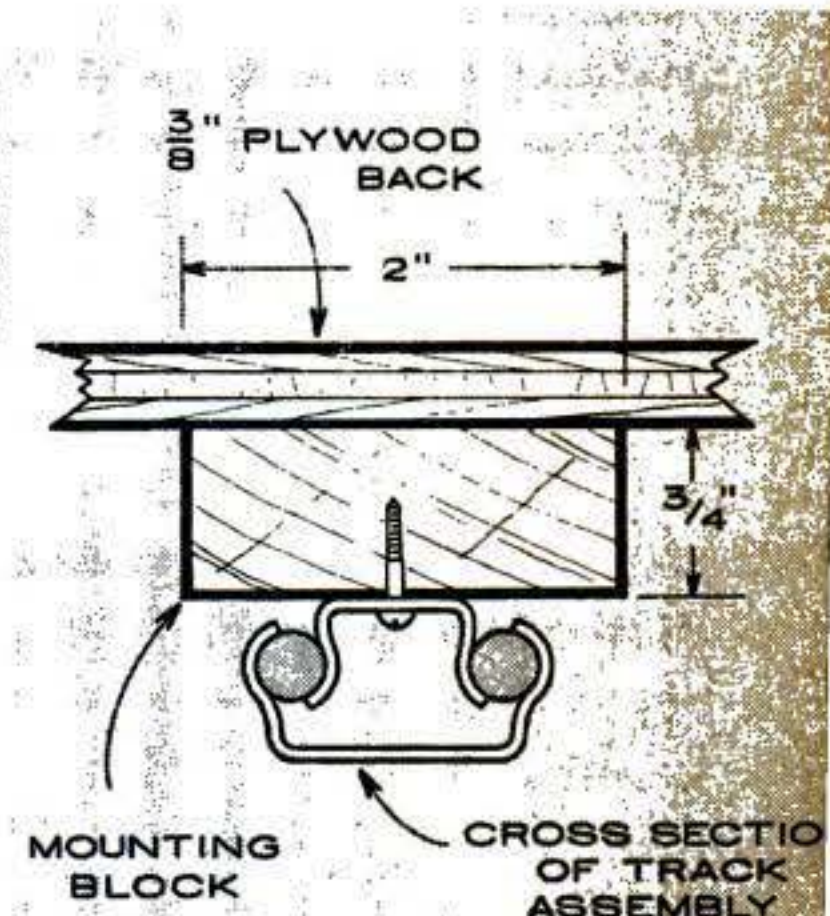


All parts of lift-up shelving, ready for assembly, above, show how laminate facing is pre-applied, with dado gaps. Cubbyhole section goes in as a unit; insert inner shelves before adding sides (right).



Top view of desk carcass shows how tracks and counterbalance units (before installation in second photo) mount to con-

To lubricate sliding top, apply pressure-sensitive nylon tape to surface of both track extensions (see next page).

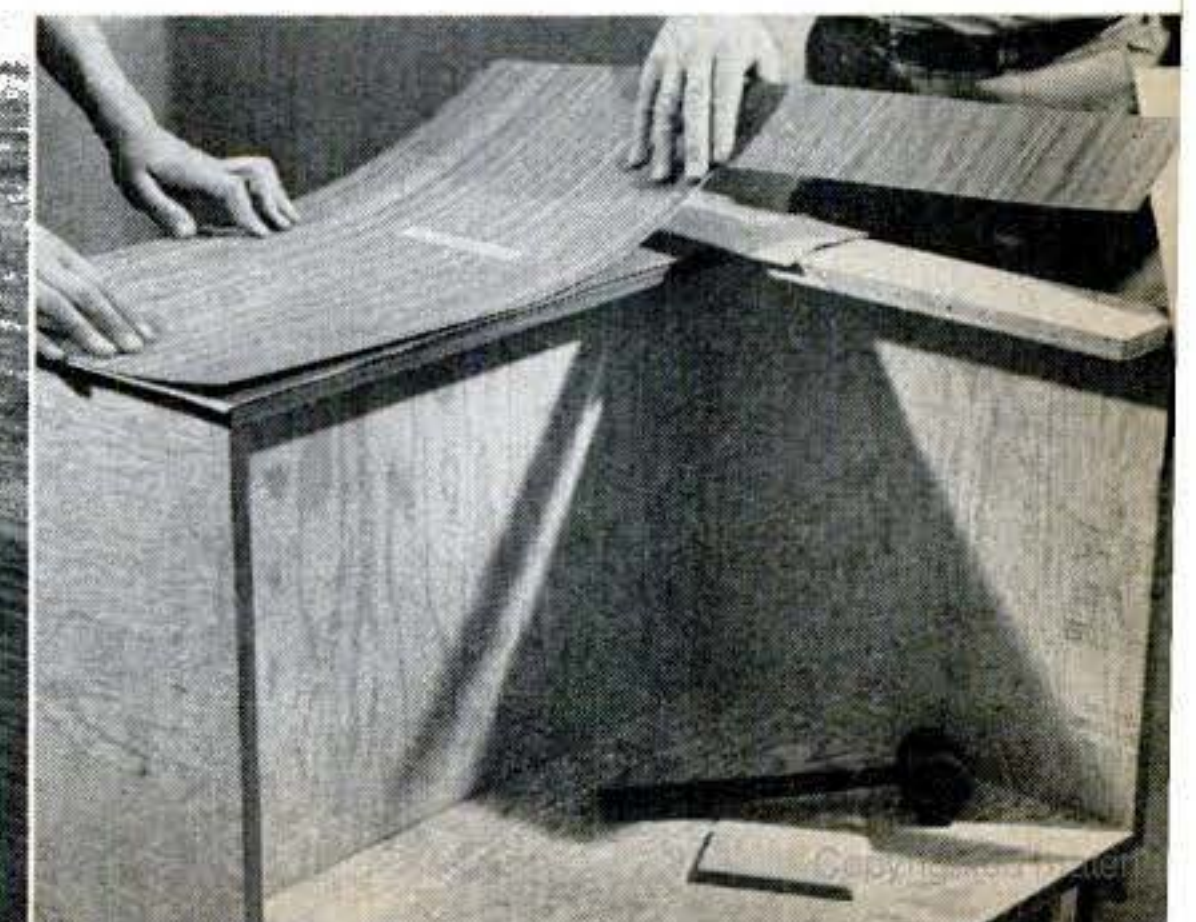
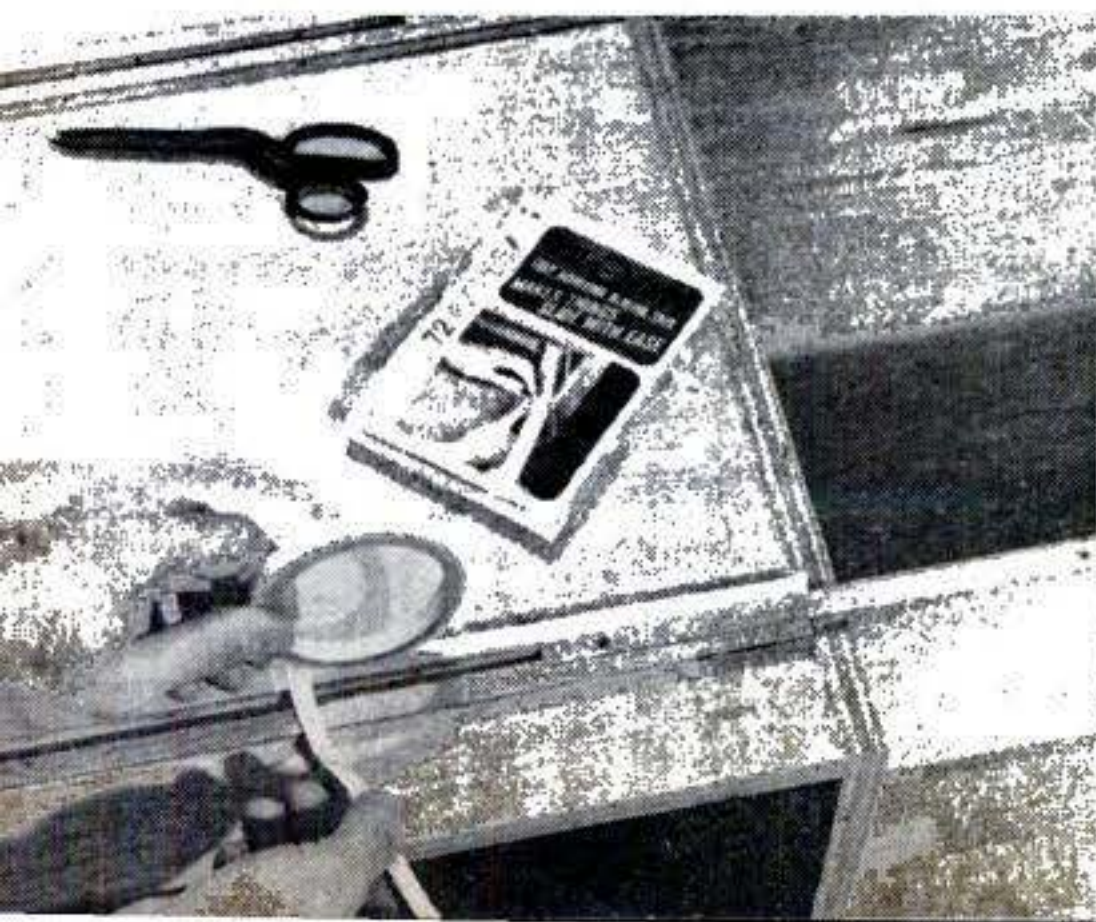


trol travel of lift-up shelving and sliding top. Two-part track (third photo) has inner and outer sections that lock together

Exact positioning of table-support hardware is vital: Follow maker's directions. Carcase is tipped onto its back, here.

over ball bearings, as shown in section of block-mounting at back of shelf unit (also see photos far left, below).

Thin Formica facing is cut slightly over-size and applied with contact cement. Remove first slip sheet after positioning.



heavy-duty Pullman window counterbalance springs and a system of tracks utilizing HDI (Hardware Designers, Inc.) drawer hardware installed vertically.

Ideal solution. These sliding tracks are ideal because the wrap-around ball-bearing feature prevents lateral play. Also, when exposed (at the sides of the raised shelf unit) the slender inner section isn't unattractive (similar tracks beneath the sliding top never show).

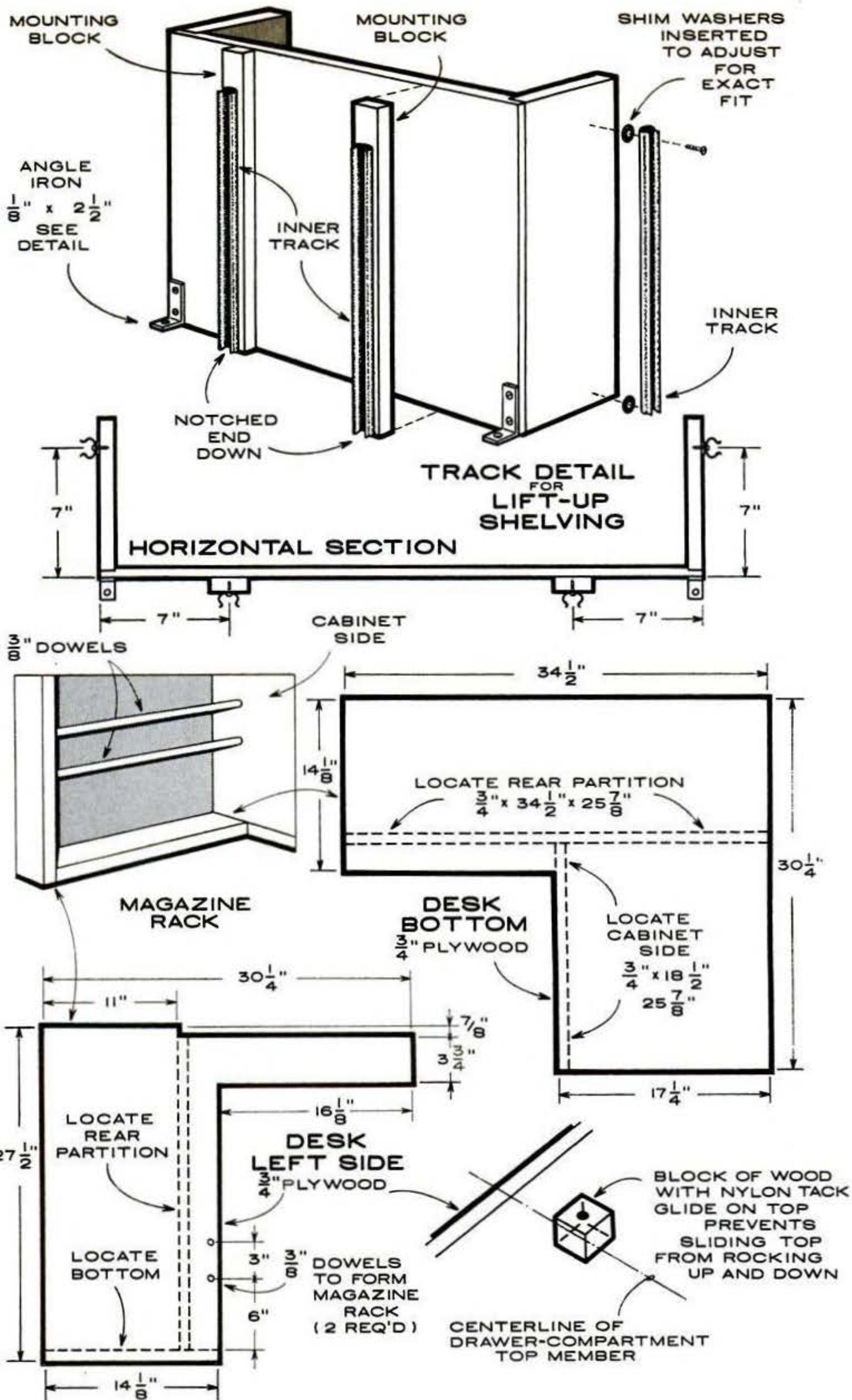
The housed springs are a commercial construction item not usually sold through local hardware dealers. Since the Rochester, N.Y., manufacturer isn't geared to handle sales to individuals, we've arranged with Constantine (the craftsman's mail-order firm) to package all the special hardware as a kit. See details under "Materials," below right.

Note that the spring housing has two flanges—ideal for screwing to the side wall and the bottom of a mounting block. The thickness of the housings creates a space between the back of the shelf unit and the tracks mounted across the rear cleats of the carcass. This space is compensated for by a pair of vertical blocks on the back of the shelf unit—see first sketch, above, right.

Track alignment. The best way to align these mating inner tracks to their already-mounted carcass sections is to screw them to these mounting blocks before the latter are attached to the shelf back. Insert the shelf unit into its well and, centered right to left, prop it up to bring the top flush with the cabinet top. Slide in the tracked cleats (notched end down) and outline their positions on the back of the shelf unit. (Note: A sharp push is needed to get the notched ends past the outer-track bearings.) Once you've installed the rear pairs, mounting the side tracks is a cinch. Just install with an appropriate number of shim washers to take up slack and permit adjustment.

To connect the spring end loops, prop the shelf unit in its *up* position and pull out enough spring to hook the loop into the slightly opened eye bolt. HDI's Tack Glides and Nyl-O-Tape are needed to counteract a slight forward leaning due to the uncentered rear location of the springs. The tough nylon head is a fine friction-free bearing surface against the Formica edge. A block of wood with a strip of the self-adhering tape running down its middle is installed at the back-center of the well for added vertical stability. (Both types of nylon are further utilized with the sliding top.)

[Continued on page 144]



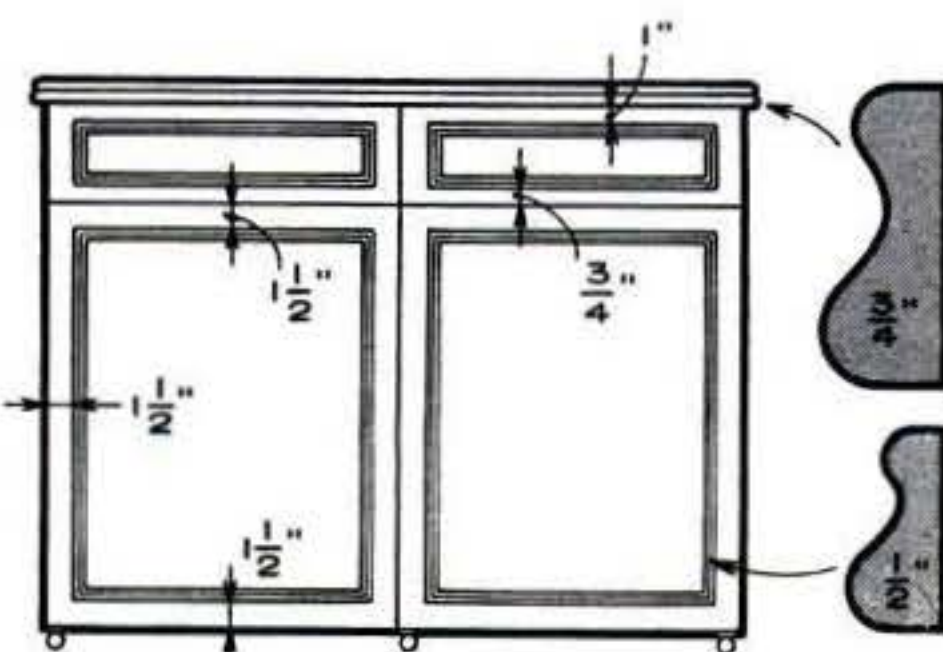
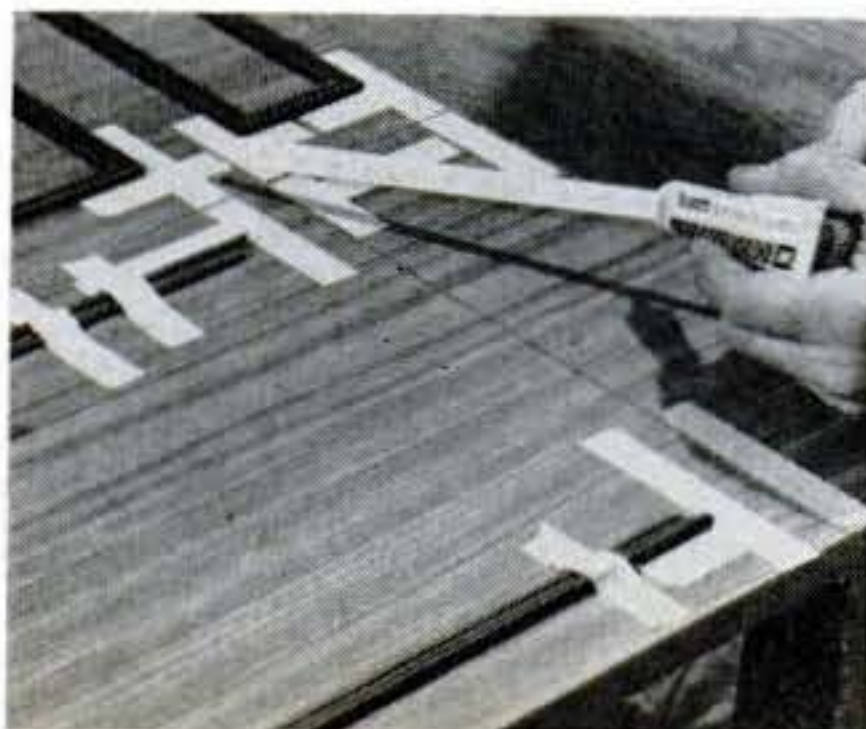
MATERIALS

3/8", 1/2", 3/4" fir plywood
1/32" Formica: Teak #417, White #949
1/2" and 3/4" Waddell molding
2"-dia. Global plate casters
1 1/2" strip hinges
10" Stanley folding bracket

Available as a kit from A. Constantine Co.,
2050 Eastchester Rd., Bronx, N.Y. 10461
(\$29.75 plus postage):

3 pair 22" #703 drawer slides (HDI)
1 pair 16" #703 drawer slides (HDI)
1 roll 72" Nyl-O-Tape #IP572 (HDI)
3 tack glides #3368 (HDI)
1 pair spring counterbalance (Pullman)

Molding is final touch



Masking tape is big help in fitting mitered trim: Use it to secure assemblies and for "register marks" at corners.



WINTER WORKSHOP

By RICHARD C. SICKLER

DESIGN AND PHOTOS BY AUTHOR
DRAWINGS BY CARL DE GROOTE

Here's a desk for the family to fight over. It goes wherever it's wanted (taking its lamp along) and hangs from a pair of picture hooks on any wall. Your wife will use it in the kitchen for menu planning; you'll move it to the den to go over household accounts while keeping an eye on the TV ballgame; a teenager may

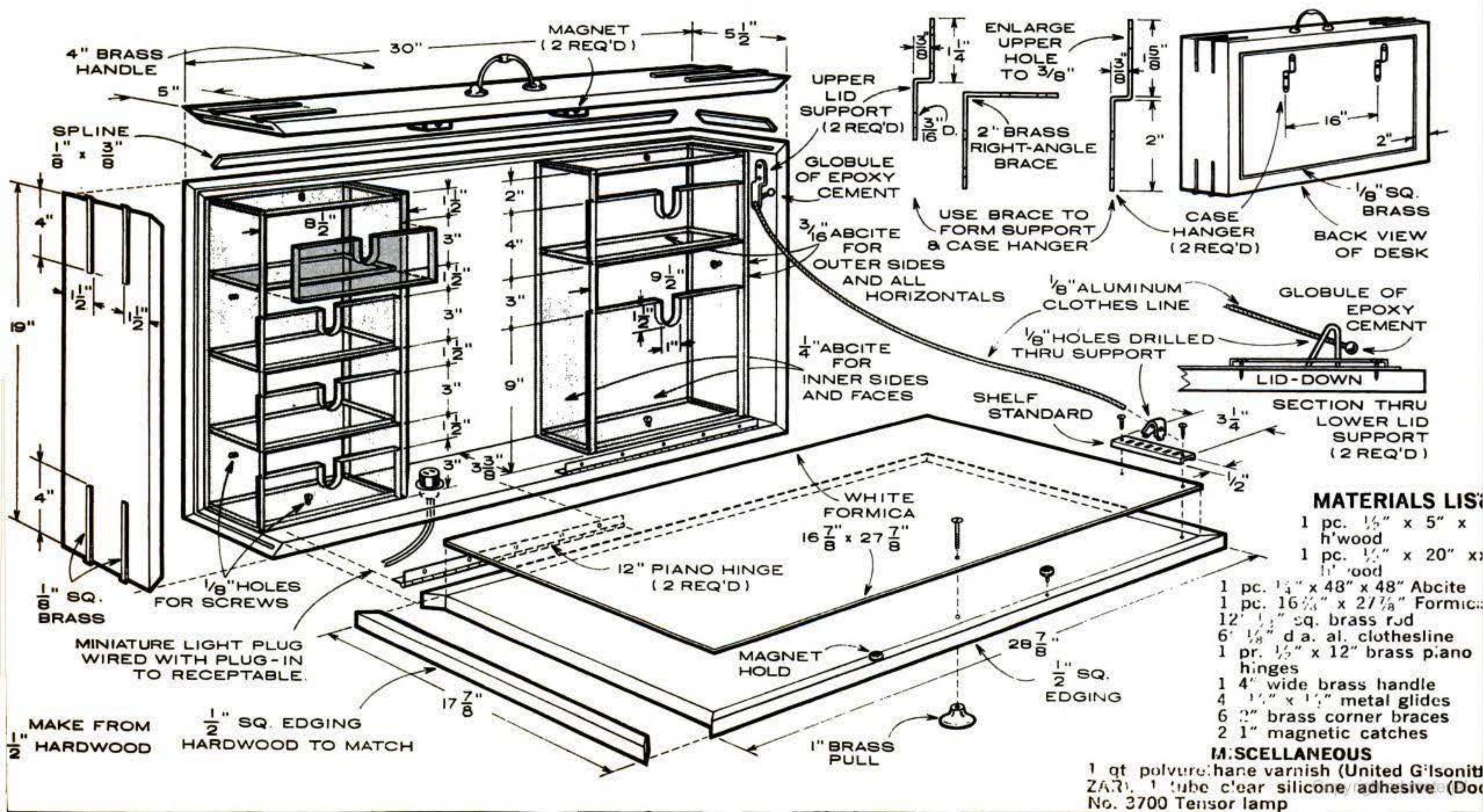
spirit it away to her room for letter writing. Come spring, when you all shift these tasks to the patio or porch, the desk moves outside.

Those see-through cubbyholes are made of a new plastic sheet—Du Pont's Abcrite. Actually, it's acrylic-like Plexiglas or Lucite, but it's coated with an abrasion-resistant fluoropolymer. I chose it because a transparent material makes sense here, allowing a visual check of all contents before you pick up and go. And the cubbyholes need front closure to prevent spillage in transit.

Unsurfaced plastic might scratch especially with those drop-leaf support cables coiled against it for travel. The coating prevents use of a standard solvent adhesive for joints; however, I experimented with several alternates, and settled on Dow's clear silicone adhesive.

Construction. Begin with the case. I used 1/2" Philippine mahogany; back and lid panels are glued up from three butt-joined boards. You could, of course, substitute 1/2" cabinet plywood to avoid this, using

[Continued on page 132]



Phone Desk for Your Bedside

By A. J. HAND
DESIGNED BY GARY GERBER
PHOTOS AND DRAWINGS BY DESIGNER

If you have to work, there's no nicer place to do it than in bed. Here's a desk that makes that kind of relaxed labor possible. Its top slides out over the bed to give you a no-nonsense work surface. There's none of the slipping and sliding of papers you get with a lap board. Inside the desk there's room for typewriter, papers, phone and phone books, and the usual office odds and ends. There's even room for a portable TV. After a late-night work session you can let the Late Show put you to sleep.

The desk is just right for convalescents, too. The work surface doubles as a mealtime table. And if you stay home from the office with a cold for a day or two, the bedside desk helps you keep up with your work.

Industrial designer Gary Gerber created the desk from mahogany-faced plywood, but any $\frac{3}{4}$ " hardwood plywood will do. Plans on the next page dimension all parts.

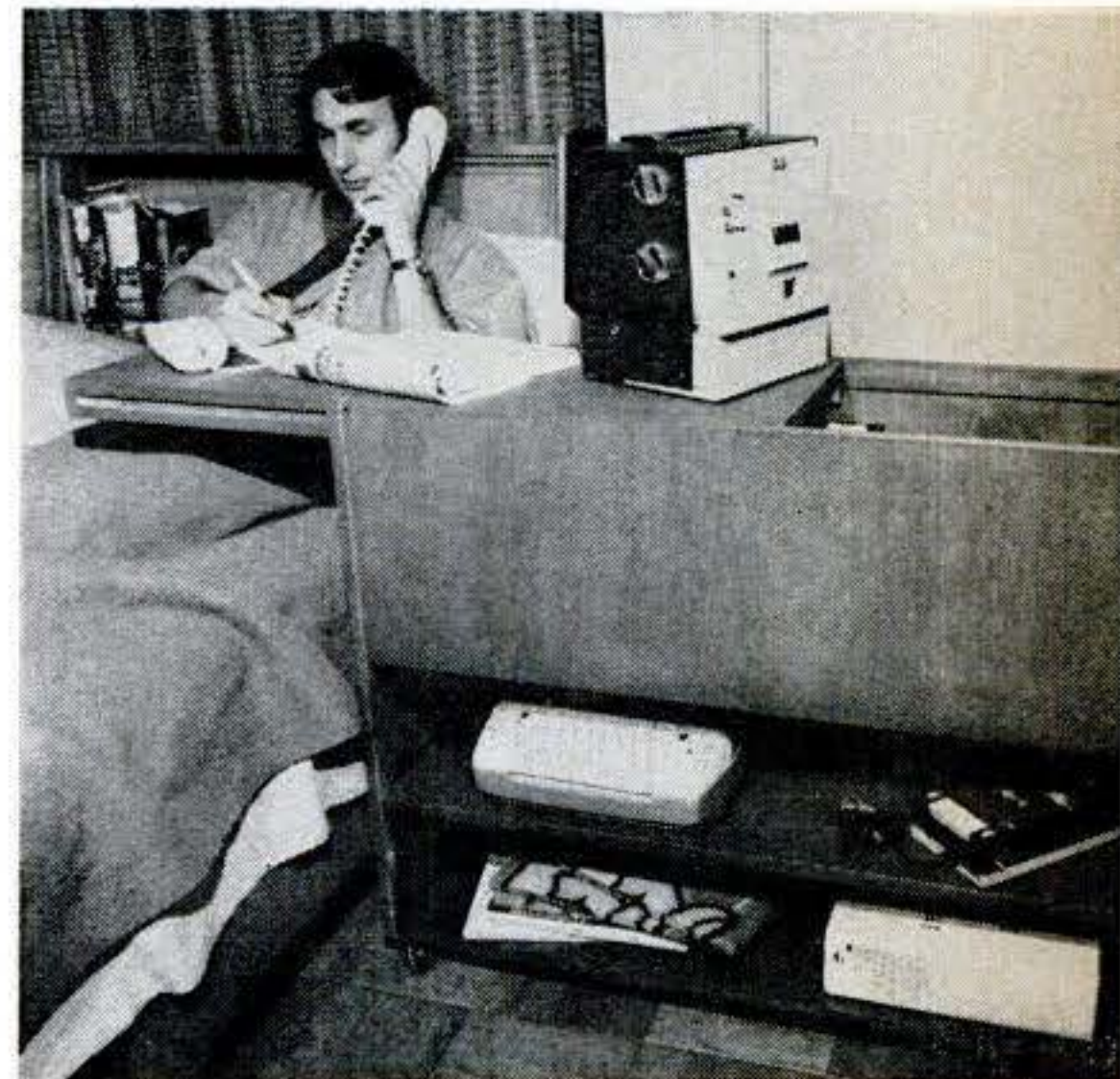
Assembly. Start by cutting out the bottom, sides, front, and back, as well as the hardboard shelf. Then cut $\frac{1}{4}$ "-by- $\frac{1}{4}$ " dadoes across front and back panels—12" from their top edge—to accept the shelf.

Now you're set to assemble the main body of the desk. Note the unique method of joinery used at the corners. The aluminum angle covers the edge grain of the plywood and at the same time provides metallic accent lines.

Assemble the desk body using screws through the aluminum angle and white glue at all wood-to-wood joints. Join the front and back to one of the sides, slip the shelf into its dadoes, then add the other side. Use bar clamps to hold sides and back in firm contact with the bottom while the glue dries.

Meanwhile, go to work on the top and its track and the phone stand and its cleats. The cleats for the stand go into place first with glue. The stand glues in on top of them.

For smooth operation of the sliding top, use special care when making the track and runner. Use hardwood for both to get long wear. Check them for a smooth-sliding fit,

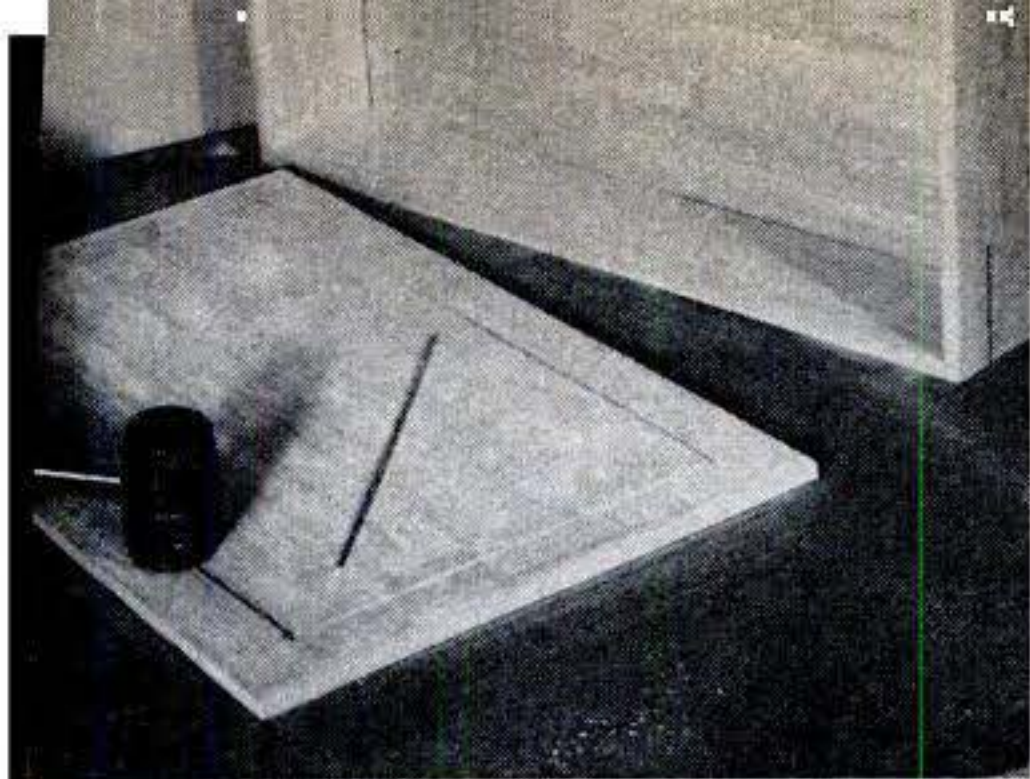


A life of leisurely labor is yours with the bedside desk. Slide-out work surface gives you space to write or type. Inside and on lower shelf go phone and directories, typewriter, TV, papers.

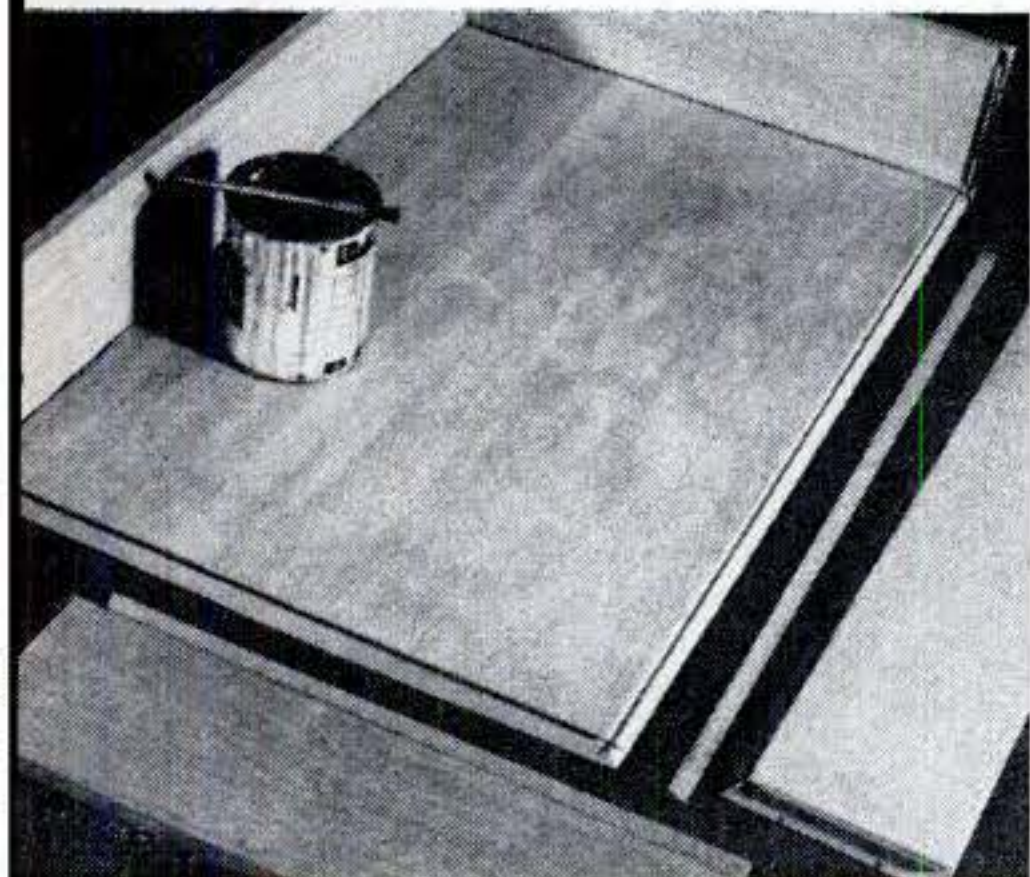
and block-sand the mating surfaces. Glue the runners to the top. Glue and screw—with $1\frac{1}{4}$ " flatheads—the tracks inside the case. Note: The finished top will be edged with veneer tape. Be sure to allow for the extra thickness of the veneer or the top will bind. Even so, you'll want to keep tracks and runners waxed.

The lower shelf and directory holder are no problem. Build the holder with or without rabbets and dadoes

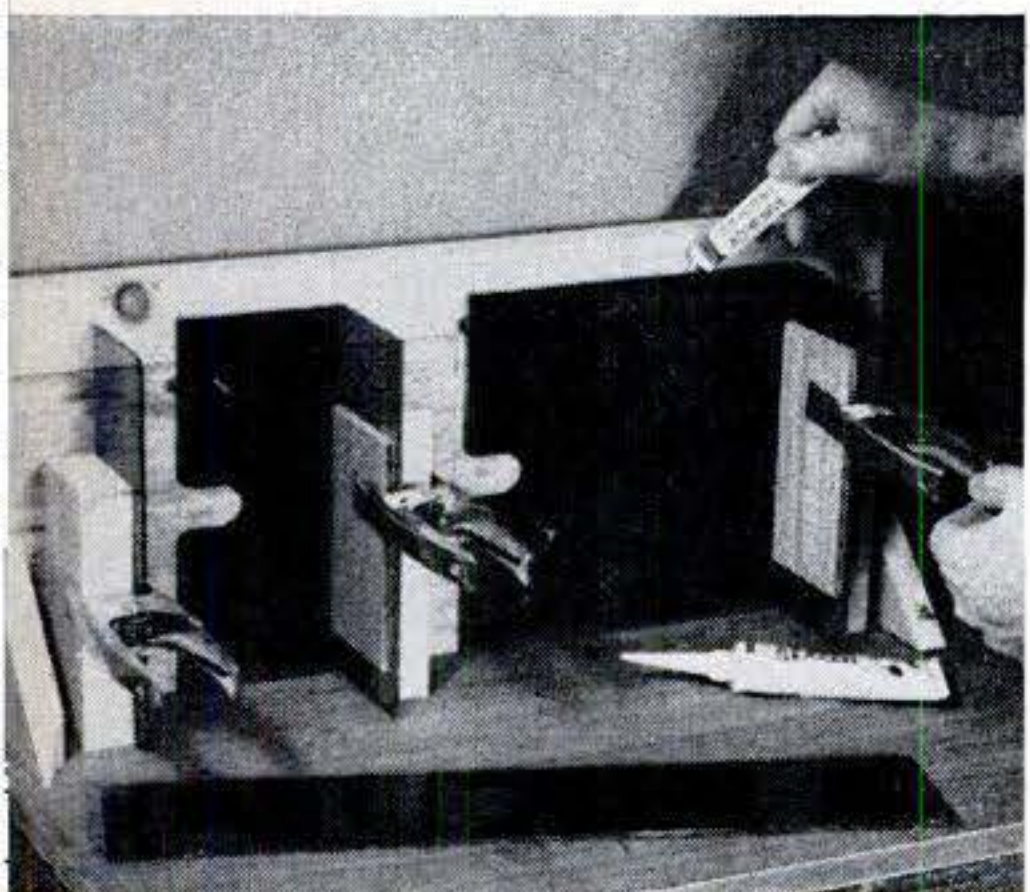
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Brass rod, $\frac{1}{8}$ -inch square, is embedded in routed grooves with a mallet before final sanding. Ends can be mitered or butted. Corners of case get trim, too.

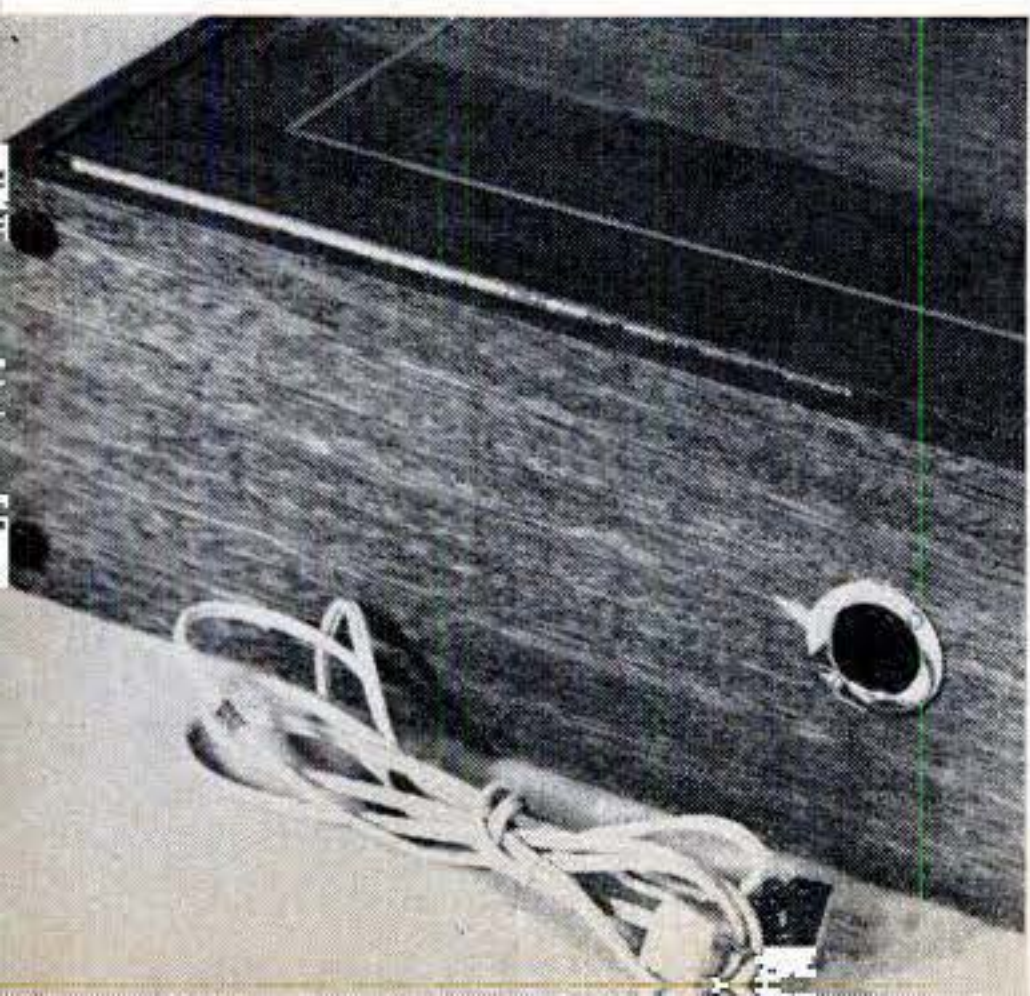


Mitered and splined edges of case parts assemble a side and an end at a time. Snug joints with clamps while glue sets. Spline kerfs were cut on table saw.

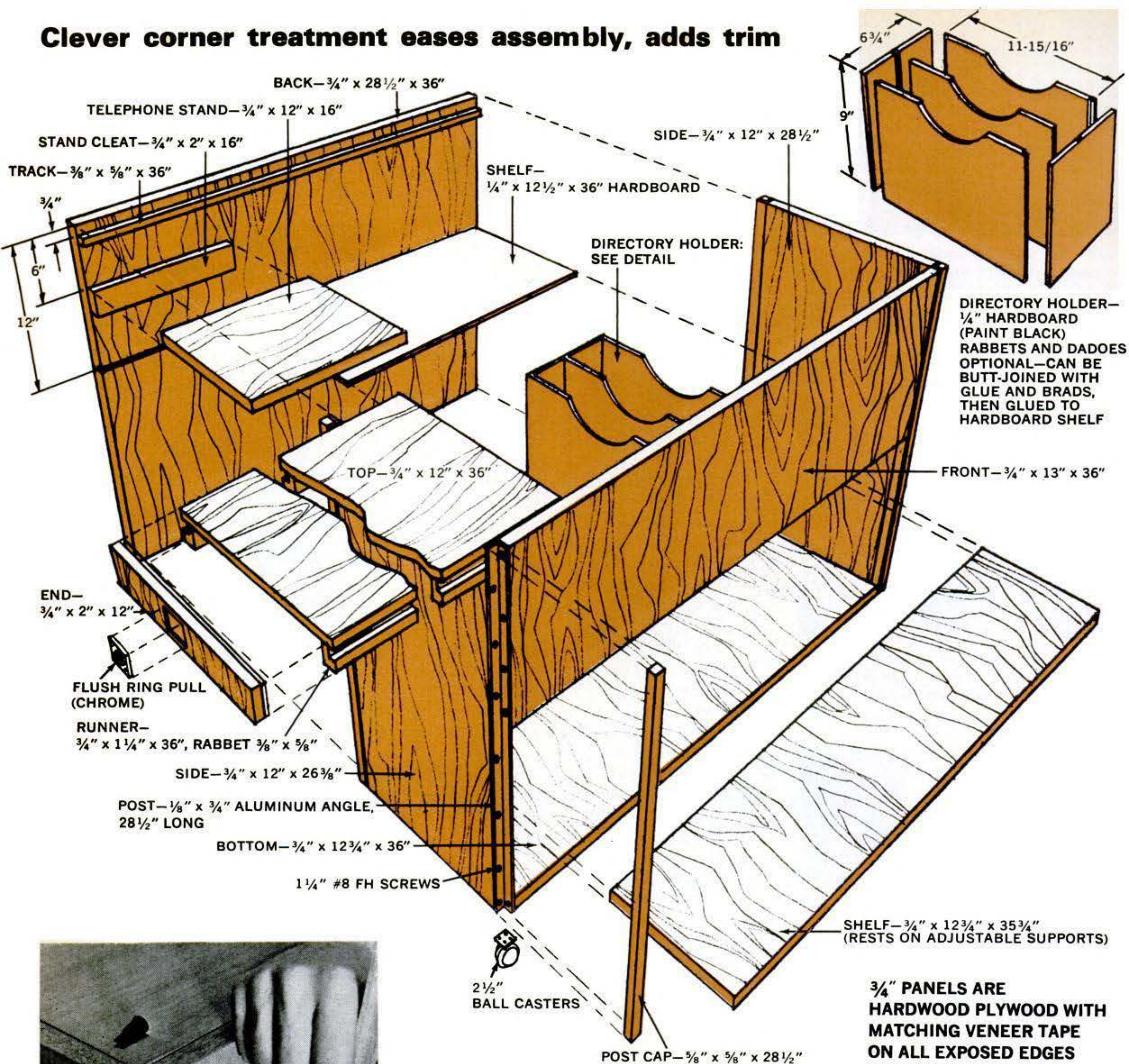


Simple jig assures square assembly of two Abcite units (sketch, far left). Clamp parts to blocks, run thin bead of silicone on edges, weight side panel in place.

Miniature outlet is mounted in bottom of case, with lamp wired to it. Rest of lamp's cord can be used as double-plug extension. Corner glides preserve finish.



Clever corner treatment eases assembly, adds trim



Post caps cover aluminum angle at corners. Secure caps with contact cement. Be sure screwheads are countersunk so strips set in flush.

MATERIALS LIST

3/4" HARDWOOD PLYWOOD

- 1 Back: 28 1/2" x 36"
- 1 Front: 13" x 36"
- 1 Right side: 12" x 28 1/2"
- 1 Left side: 12" x 26 3/8"
- 1 Bottom: 12 3/4" x 36"
- 1 Shelf: 12 3/4" x 35 3/4"
- 1 Telephone stand: 12" x 16"
- 1 Top: 12" x 36"

HARDWOOD TO MATCH

- 4 Post cap: 5/8" x 5/8" x 28 1/2"
- 1 End: 3/4" x 2" x 12"
- 2 Runner: 3/4" x 1 1/4" x 36"
- 2 Stand cleat: 3/4" x 2" x 16"
- 2 Track: 3/8" x 5/8" x 36"

1/4" HARDBOARD

- 1 Shelf: 12 1/2" x 36"
- 5 Directory-holder parts (see dimensioned detail)

MISCELLANEOUS

- 4 3/4" alum. angle: 28 1/2" long
- 4 2 1/2" plastic ball casters
- 1 1 1/4"-sq. flush ring pull

and paint it black. It needs no bottom since it glues to the hardboard shelf. The lower shelf can rest on cleats instead of adjustable supports, if you like.

Finishing up. All exposed plywood edges get the veneer tape treatment now. So does the end piece for the top. At the corners, install the postcaps. Contact cement does the job here. Just spread the cement, set the strips into it and hold fast with strips of masking tape.

Before applying a finish, screw the casters to the bottom. They'll lift the desk off the floor and simplify your brushwork. Natural oil gives good protection with very little work. Use varnish if you prefer to have a built-up finish that minimizes wood texture.

ONE-WEEKEND PROJECT
\$200
AWARD
EACH
MONTH
COMPETITION

THIRD MONTHLY WINNER:

Robert J. Oswald
of Tempe, Ariz.

Are you short on display space for your favorite books and magazines? Do you like the touch of life that plants can add to a room? Then build this end table. Up front is a shelf for magazines. In back, a built-in planter.

Fill the planter box directly with soil, or set potted plants in the box and cover with sphagnum moss. In either case, a waterproof planter lining is a good idea. Solder a galvanized steel liner if you like, or take the easy way out and use epoxy paint for waterproofing.

Choice of wood is yours. The table above was made of solid walnut for a little over \$20. Pine and oak (stair tread is a good source of clear oak) do nicely, too. If you want a modern, glossy plastic look, use plywood for everything but the legs and trim. Finish with enamel.

All parts of the table go together with clamps and white glue. One exception: The legs fasten on with flathead screws to allow for easy removal and transportation.

Finishing. Walnut and oak usually look best with a natural oil finish. Watco Danish Oil is a good choice. If the walnut has streaks of light sapwood, use a walnut stain before brushing on the oil. This will give the wood a uniform tone.

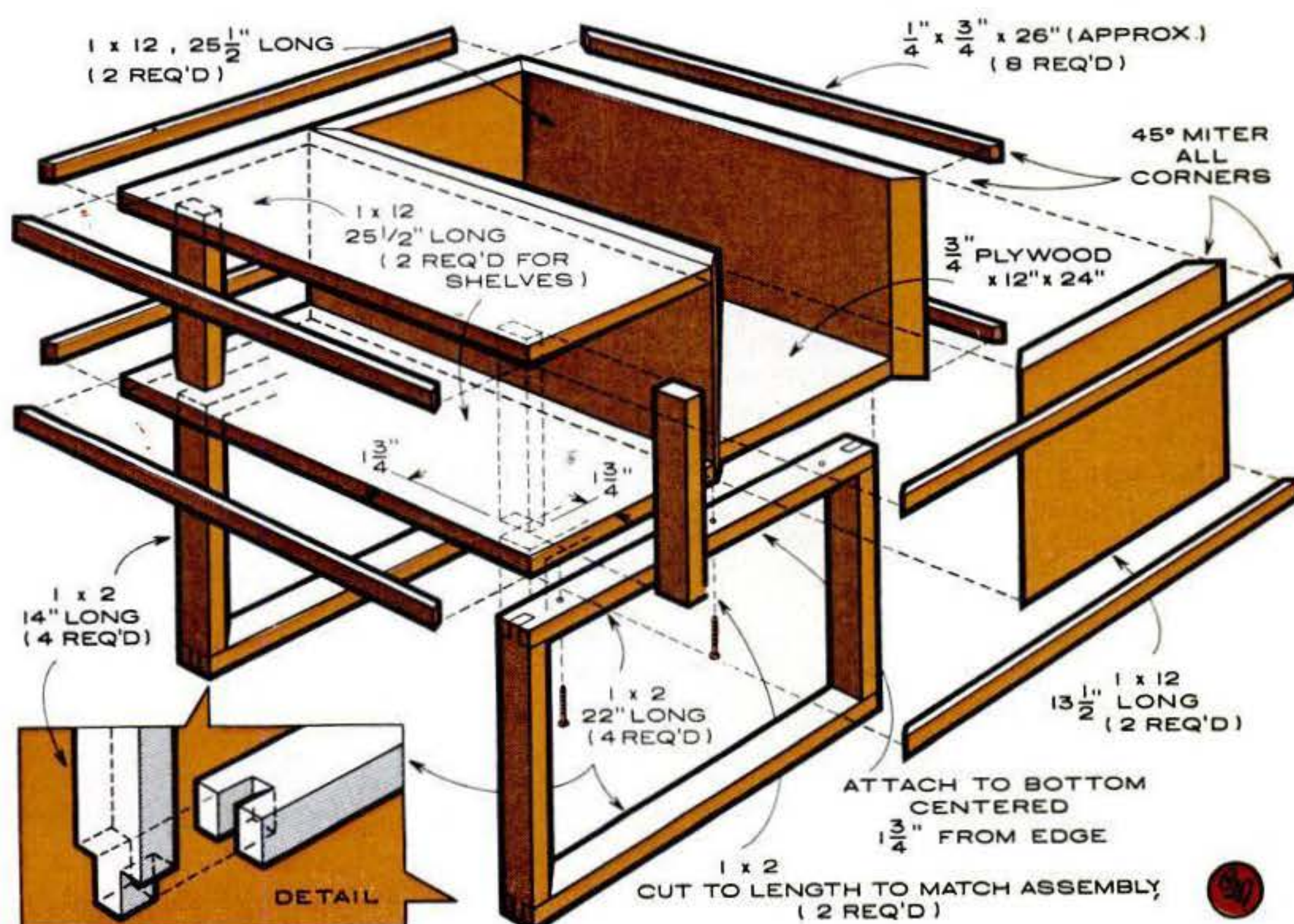
Pine is best sanded carefully, then stained and varnished. And the best stains for pine are those that simulate the look of aging.

Gloss-enamel finish requires careful sanding. Apply at least three base coats of enamel. Let each coat dry overnight, and sand between coats with 220 paper on a block. Before the final coat, wet-sand with 320 waterproof paper.—*The Editors*



Table is most at home near window where plants get plenty of light.

End-Table Planter with Magazine Shelf





WINTER WORKSHOP

A simple sandblaster you make yourself is the key to expert etchings

By A. LEE SHAWCROSS

Have you always felt that decorative glassware work was difficult, time-consuming, and best left to the experts? It isn't. You can etch a monogram on a brandy snifter in less than an hour from start to finish. And making the device to do the etching takes only an evening or two.

The object is to rough up the surface of the glass in selected spots.

Famous cover becomes an etching



As a dramatic demonstration of the quality detailing that is possible with his simple rig, the author reproduced, full size, our centennial-issue cover—complete down to the last gear tooth—and sent it to us framed with a mirror backing (a striking but unphotographable effect). When we asked Shawcross how he did it, he wrote:

"Very carefully! Made several Xerox copies of the cover to reduce it to tones of gray, then took a sharp felt-tip pen to ink out what should go black (clear) and what white (etched).

"This reduction was taped down as my mask guide. The cutting and stripping was tedious: worst was the small lettering, with artist Ray Pioch's signature a special challenge. But after 10 hours of preparation, 10 minutes at the etcher finished the job."

This can be done by acid etching, but that is messy and dangerous. Grinding is the method used by the pros, but that's what you have to be to do it successfully. Our approach is much simpler: "Sandblast" the surface through a simple paper mask.

The attachment to an air compressor (detailed next page) shoots particles of abrasive grit against unprotected areas of the glass. Each one digs out a tiny particle of the smooth surface, leaving thousands of tiny prism-like surfaces which scatter light in every direction.

The etcher. The sketch at right gives the details for making this attachment. The foam can be found at any plastics shop or any outfit that supplies packaging material. Use the 2" thickness specified or you may not have enough "hump" around the hole to press into for a seal.

As a control valve, I used a simple globe valve from my plumbing box and it works fine—I hold the piece down with one hand and operate the valve with the other. As an air valve, it leaks slightly, but the small stream of air constantly escaping from the nozzle keeps the grit from falling into the hose between shots. I have to be sure to disconnect the line between uses, though—at the quick-disconnect fitting.

If you decide to use a foot valve (available from Linemaster Switch Corp., Woodstock, Conn. 06281), put a loop in the line so grit can't fall back into it; otherwise the valve will jam up fast. And again, provide a leakage path (a small valve or orifice in parallel would do) to keep the line clear while in use.

As for grit, ordinary sand will etch, but silicon carbide is faster and better. Get it from an industrial-abrasives supplier or, as spark-plug-cleaning grit, from an automotive-supply house. Finer grit gives a smoother matte surface, but for all-purpose use a 60-mesh grit is fine.

When mounting the device, locate it as you would a spray-painting station: Keep it away from tools and equipment, since the grit that inevitably escapes will wreak havoc with machinery bearings, joints, etc.

With your attachment hooked up and loaded with grit, you are ready—with goggles on—for your first project. The numbered photos show how a brandy glass was done and this, essentially, is the process for any job.

A word about pressures. An at-the-nozzle pressure of 20 psi is ade-

quate to etch the glass, though somewhat slowly. The higher the pressure, the faster the job. Most of my work is done around 60 psi (40-80 psi range). Anything over 80-100 psi is probably too much and could pose a safety problem.

If you need help making designs, turn to drawings and photographs in magazines. Lettering systems (such as Artype, Prestype, and Letraset found in art stores) are an easy route to neat, stylish letters and numbers. In choosing designs, remember straight lines are easier to handle than curves.

Another point to remember is that you have only two "colors" to work with—clear and frosted. Lettering and pen-and-ink work are the easiest to use. Continuous tone work (photos, paintings, etc.) run the gamut from relatively easy to translate into two tones to nearly impossible for anyone but an artist to handle.

When you find a pattern you like that's the right size for the job, either copy it in a copier or make a tracing of it on onion skin. But keep the original intact as you'll inevitably want more. This copy then becomes the guide for the mask.

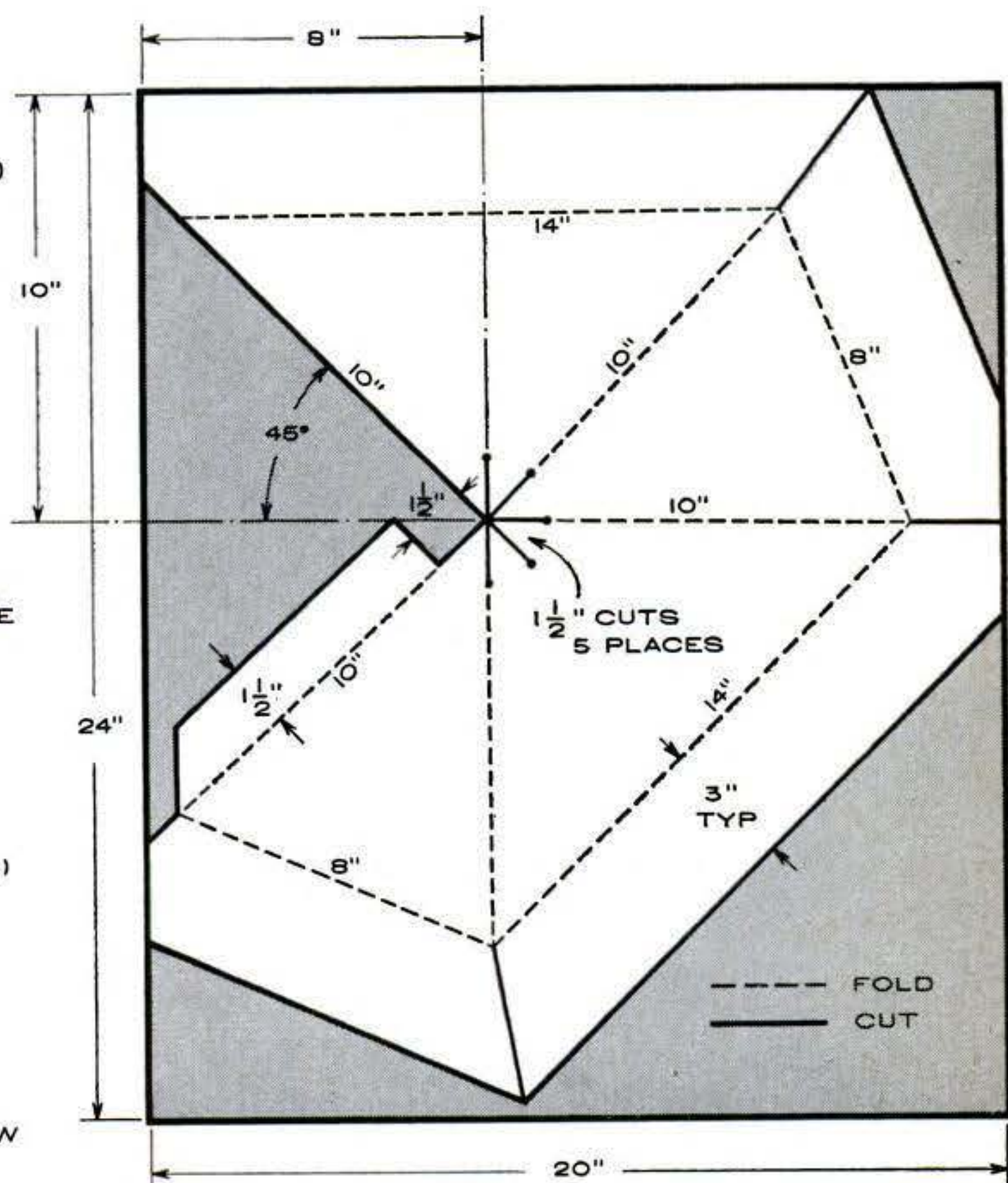
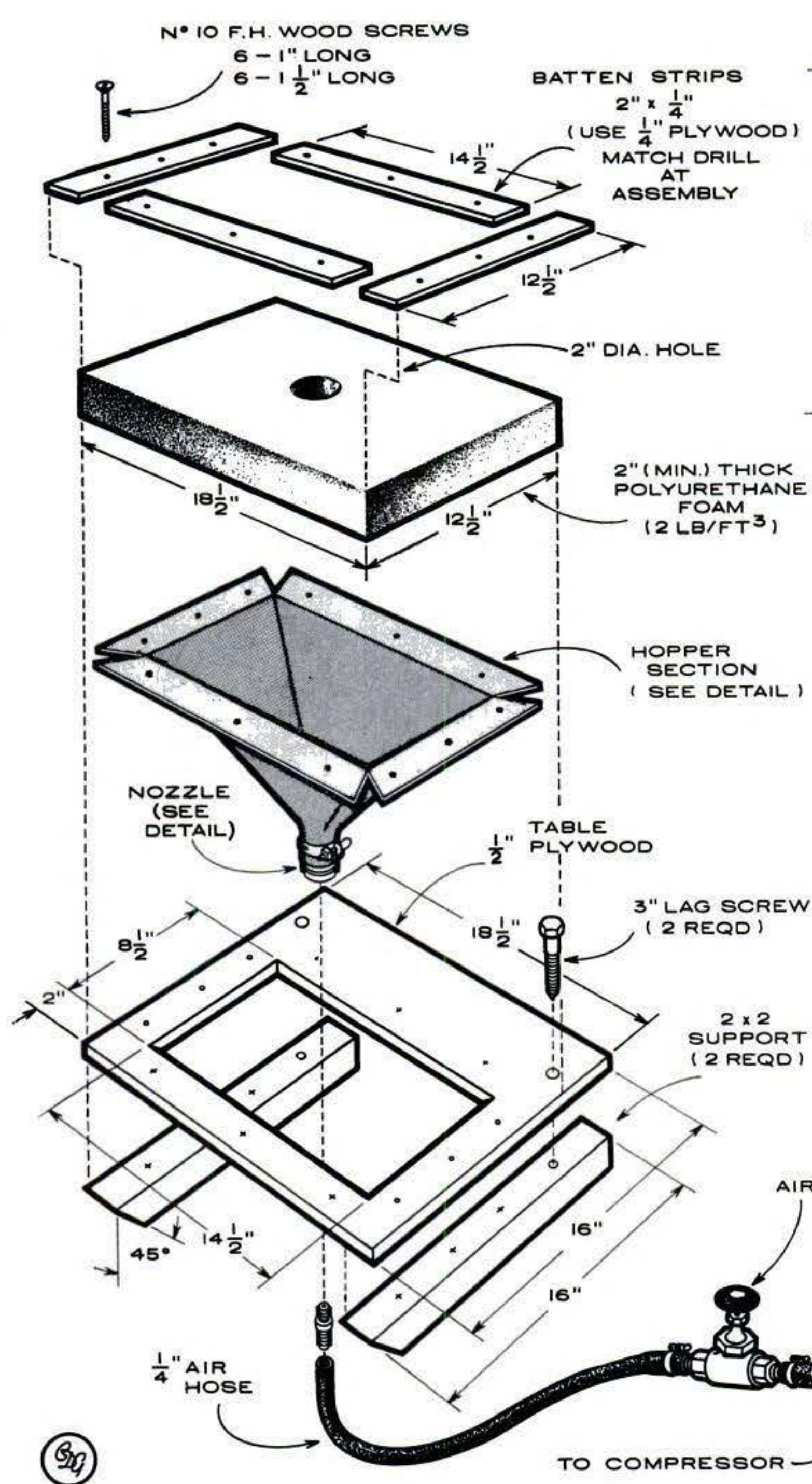
Making the cut. That's the secret of the whole process—the knife must be kept sharp and the cutting careful. Pieces of razor blade or an X-Acto knife are as good as anything I've found. But whatever knife you use should be of the best possible steel or the cutting point will dull quickly. Nothing will frustrate your attempt to do a good job like a dull knife. If the blade feels as though it's starting to drag—even a little—break it back to a new point or get another blade and use the spent one for some other job.

As you cut, you'll find you have to go slightly beyond the intersection or corner of another cut to clearly sever the tape. Be careful not to overcut too much, however, as the blade can scratch the glass (some glass is very "soft") and would leave unsightly marks projecting into otherwise clear areas.

Most pieces of tape to be removed can be lifted directly with tweezers. Thin lines—where two cuts are very close together and the tape on either side is to remain—sometimes call for a different technique. After making the cuts, position the tip of the blade or a pointed object at one end of the strip and try pushing it out of the

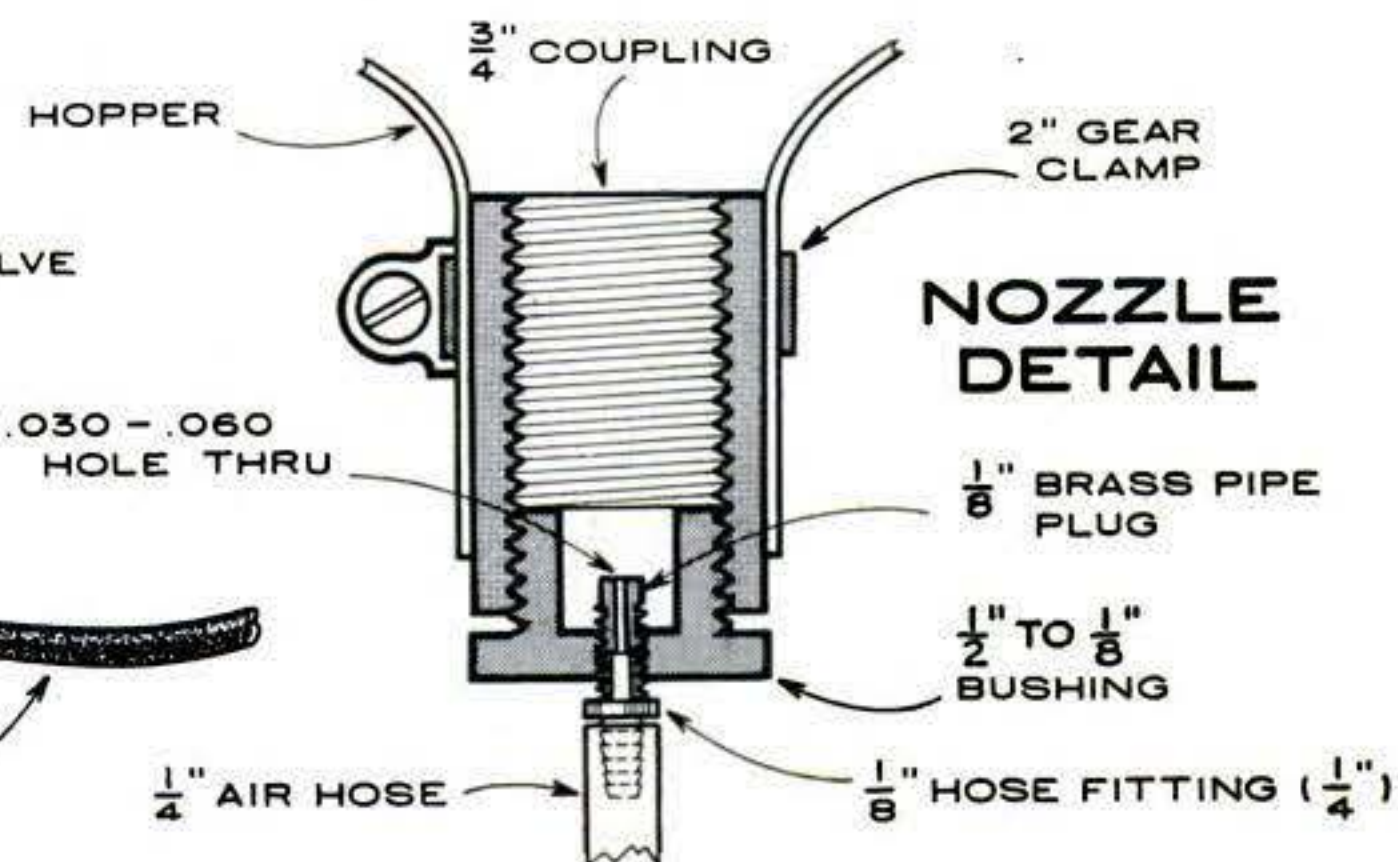
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Is Easier Than You Think



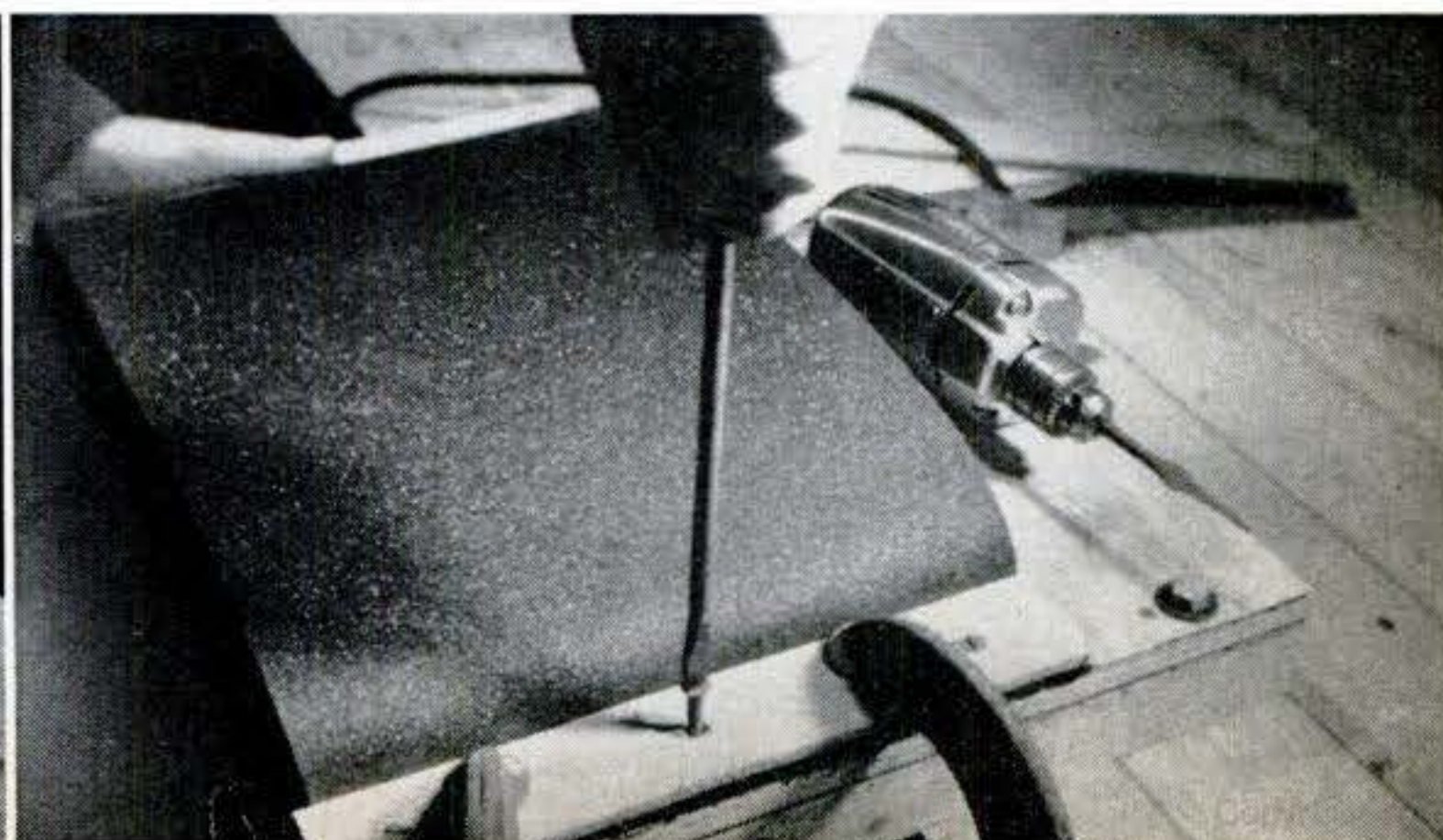
HOPPER LAYOUT

USE .020" FLASHING AL.
STD. WIDTH - 20" MAX.

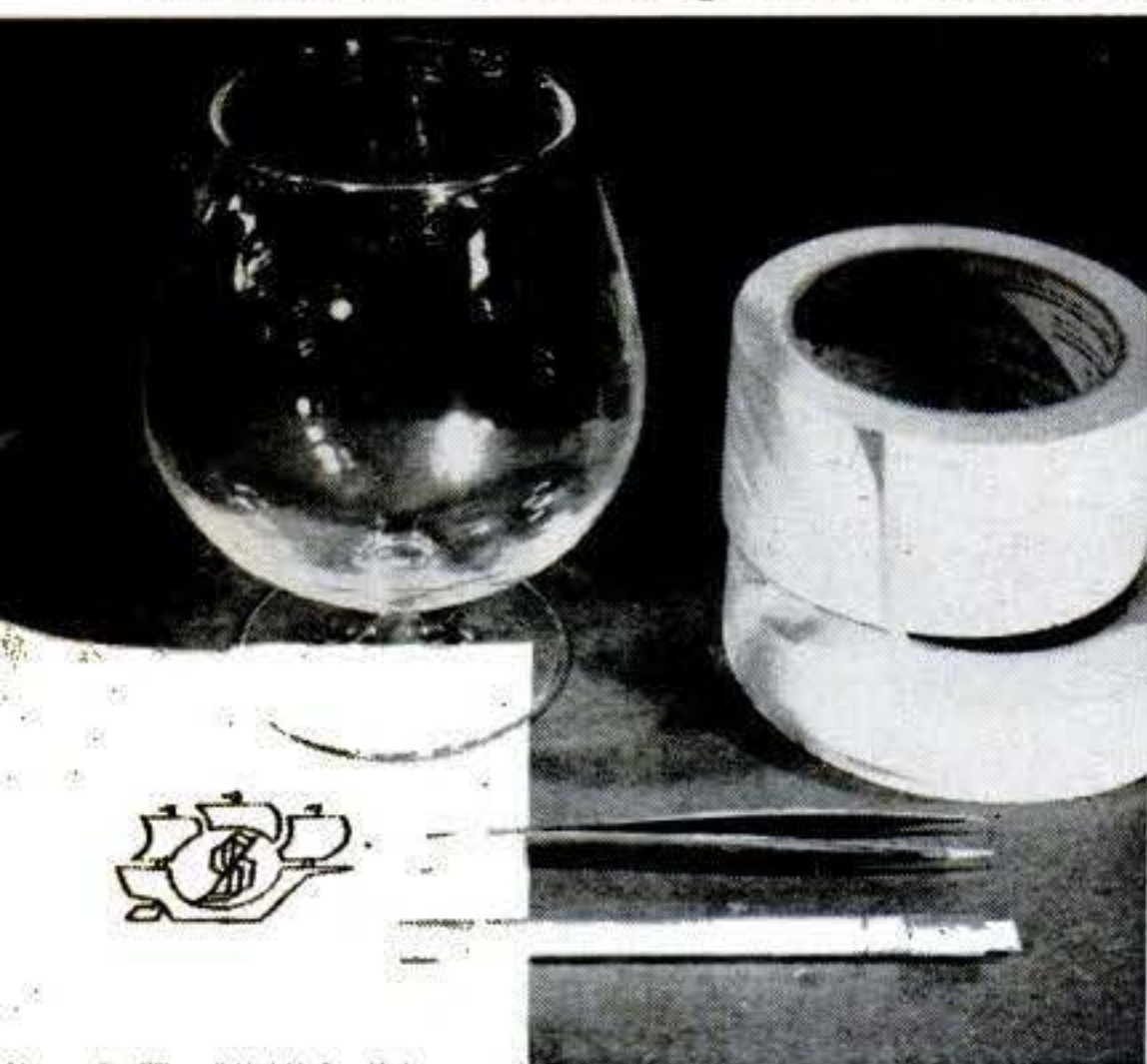


Etching attachment is easy to make. Aluminum hopper is bent and riveted to shape, all seams silicone-caulked to prevent grit leakage. Hose clamp secures nozzle to hopper.

Two-inch-thick urethane foam forms etcher's work surface. Clamp the foam down over hopper, screw in place with battens. Be sure to pull the foam down good and tight all around.



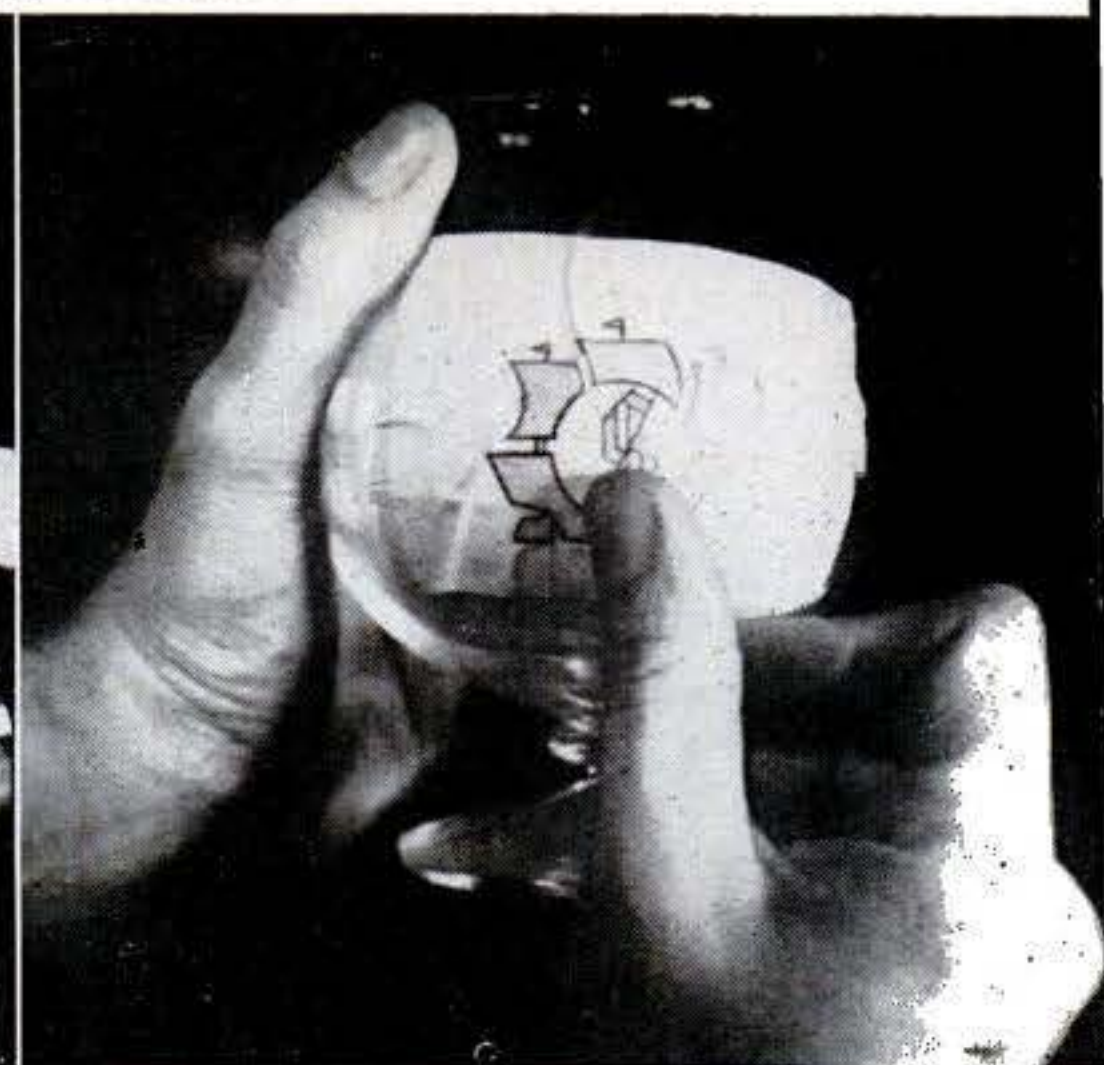
How to etch your own family heirloom in seven easy steps



1 Materials for making paper mask include pattern, double- and single-faced tapes, supersharp knife, and tweezers. Pattern here is monogram on ship.



2 Cover area to be etched with double-faced tape. Extend tape at least an inch beyond pattern. Keep exposed surface clean so pattern will stick.



3 Position the pattern where you want it and work it down firmly onto the tape surface. On curved surfaces, distribute any wrinkles evenly.



4 Cut along pattern lines with knife. Do a careful job—this is the critical step. Note that area around pattern has been covered with masking tape.



5 Peel off mask and tape where etching will take place. Tweezers are the ideal tool for this job. After peeling, check the mask for flaws. Fix them.



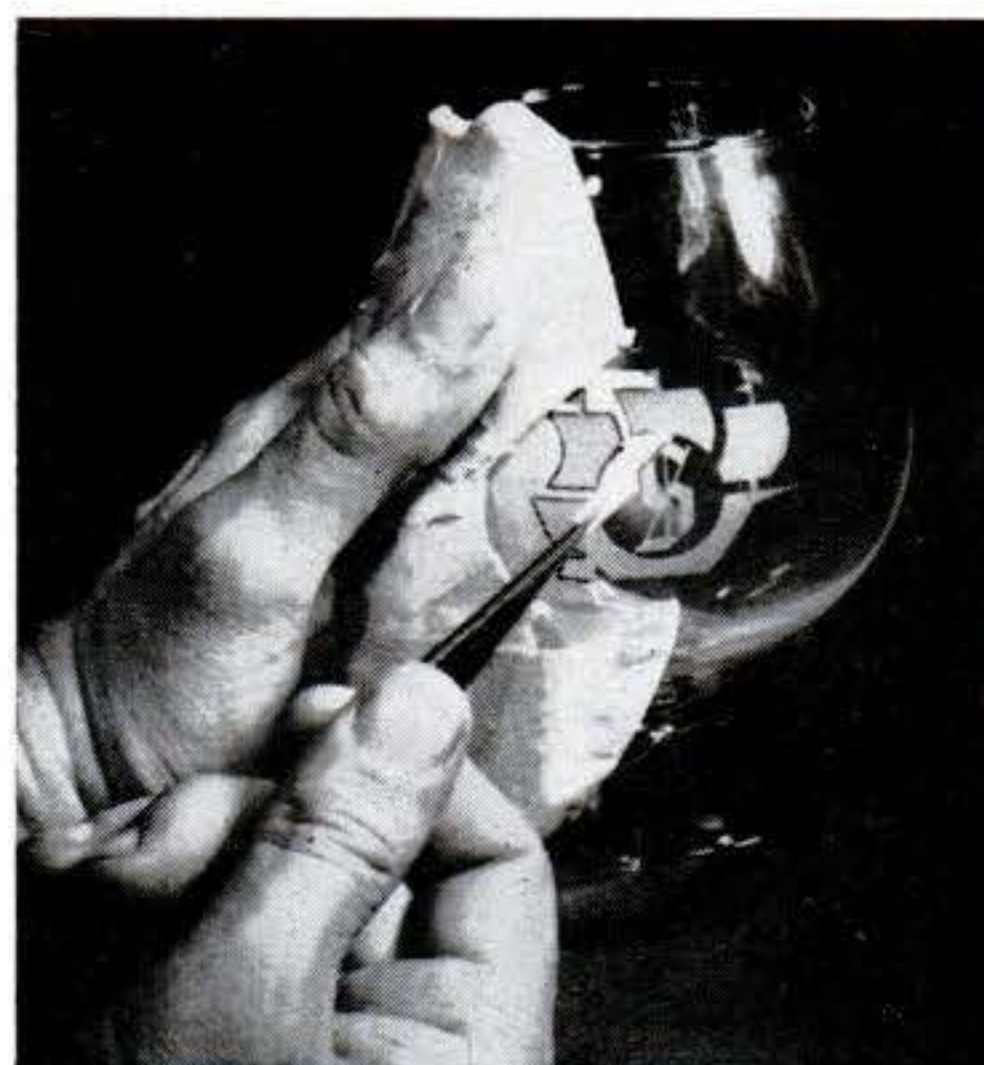
6 To start etching, press exposed area firmly but gently down over the hole in foam work surface. Use overlapping two-second blasts on design.

mask along its length. It won't slide, of course, but it will bunch up ahead of the point as you go, and then you can lift the bunch clear with tweezers. Lines no wider than the thickness of your knife blade can be cleared neatly and easily this way.

Before you etch. Take a close look at your mask to be sure it's right. After the grit hits it, it's too late; the resultant pattern is amazingly faithful to the mask in every detail. If at any point you are not sure of what you're doing, try it on scrap glass first.

The actual etching operation is fast and simple. Press the work down over the hole in the foam work surface. Turn on the valve to give a two-second blast of grit. Turn off the valve, move the work slightly, and give it another short blast. Overlap the blasts to cover the entire area to be etched.

Cautionary notes: Always wear goggles while working, and never



7 Remove the remaining mask and tape, clean the glass, and check your results. This method of etching allows for very fine detail with careful work.

open the valve without work in place over the hole in the foam.

Inspect the mask and fix any flaws before you start etching.

Check your work as you go. Hold



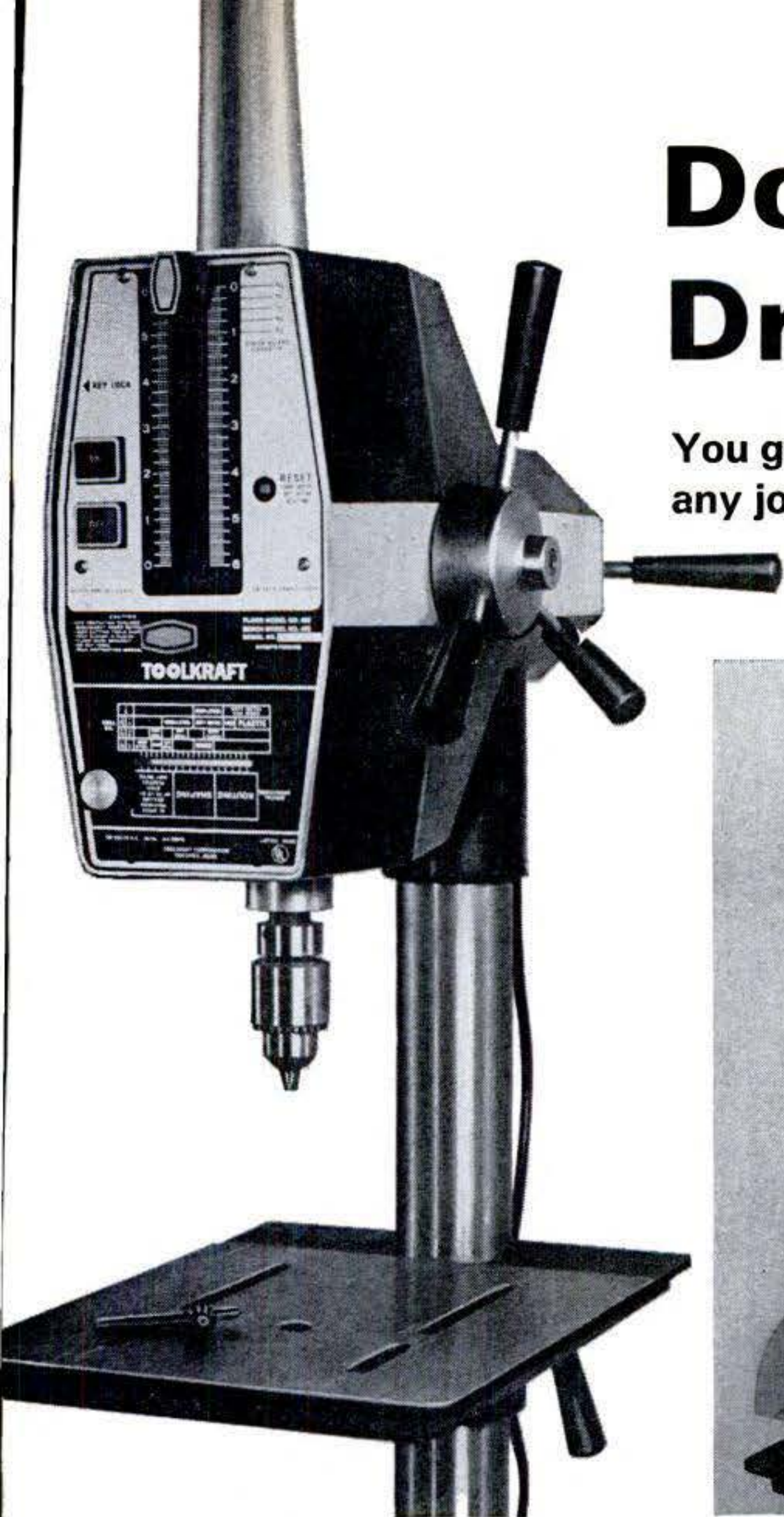
Finished snifter becomes a work of art. Practice a few designs on scraps of ordinary window glass before you attempt to etch expensive glassware.

the glass up to a light and look through the etching. You can easily spot any areas that call for another shot. But the etching goes quickly—don't overdo it.

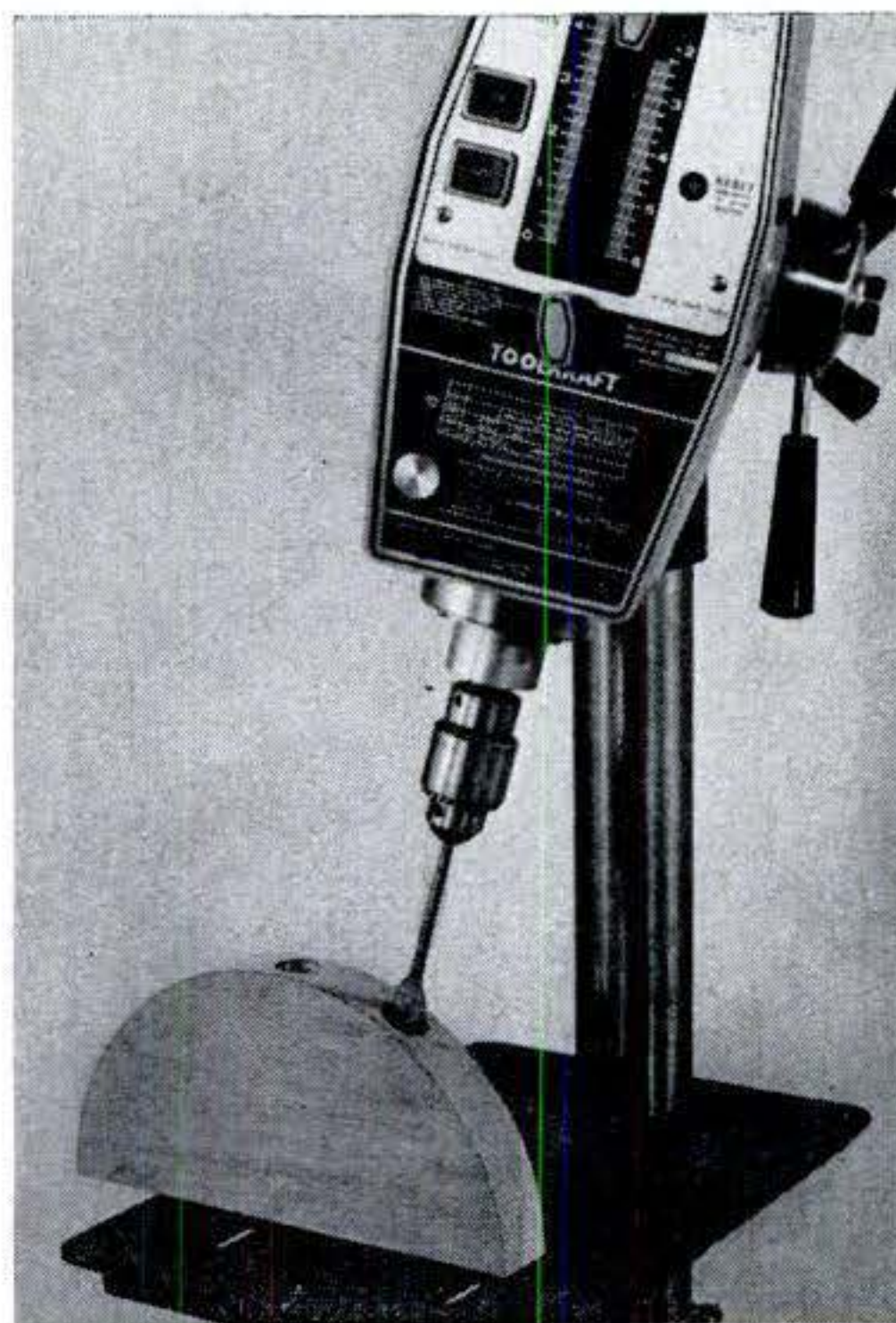
Do-It-All Dual-Spindle Drill Press

By R. J. DeCRISTOFORO

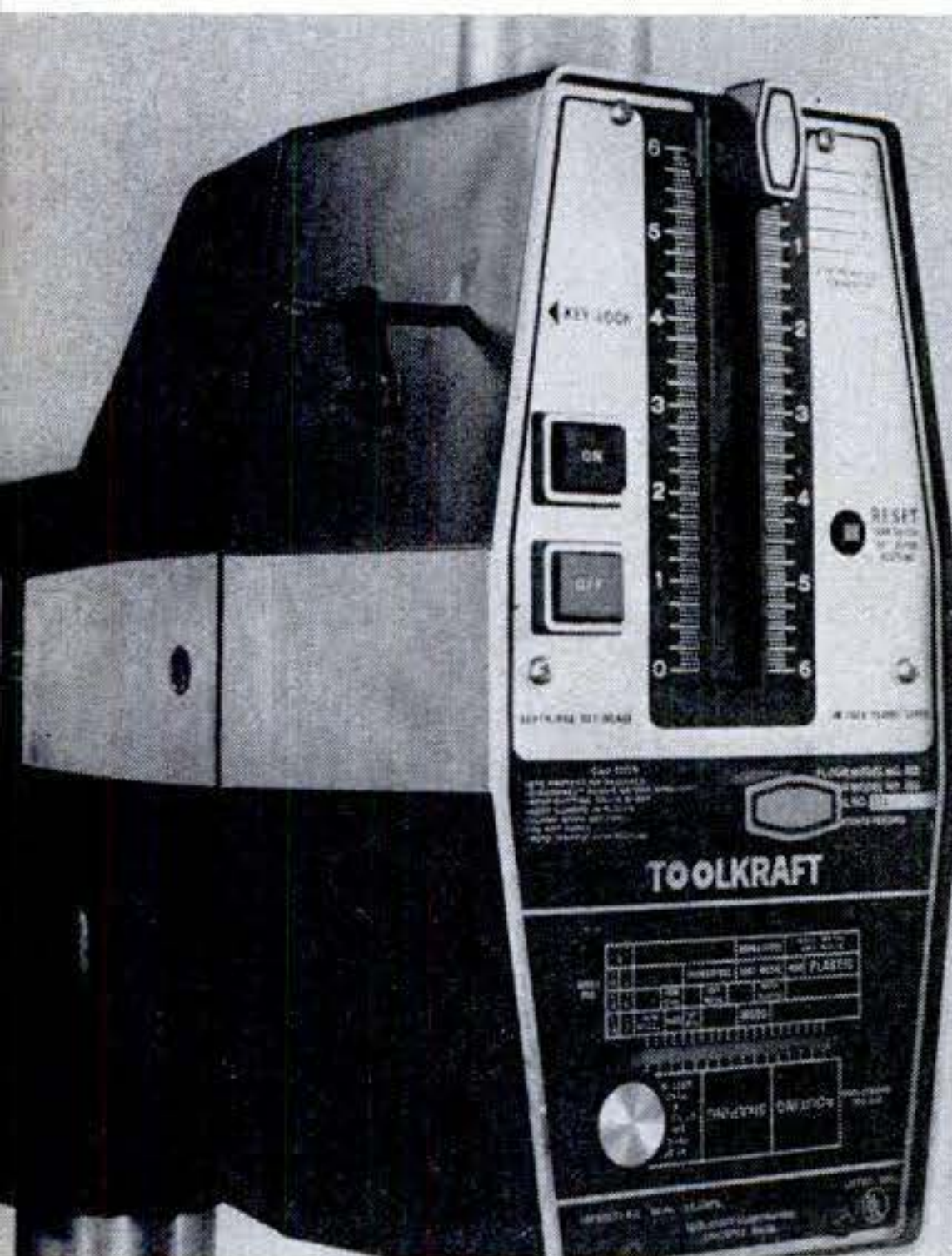
You get an rpm range from 500 to 21,000—good for any job from drilling steel to routing



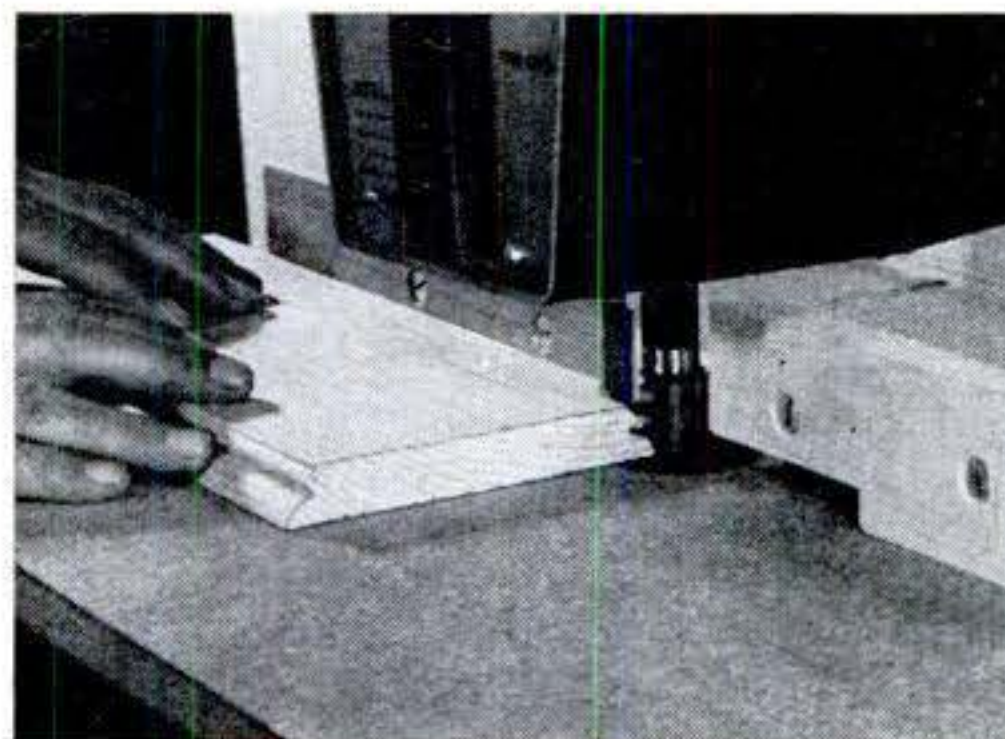
Toolkraft's drill-router has all data and controls on front panel. Plastic guard on top covers unused spindle.



Radial drill press is a bonus you get from the swinging head. A collar behind head is calibrated in degrees.

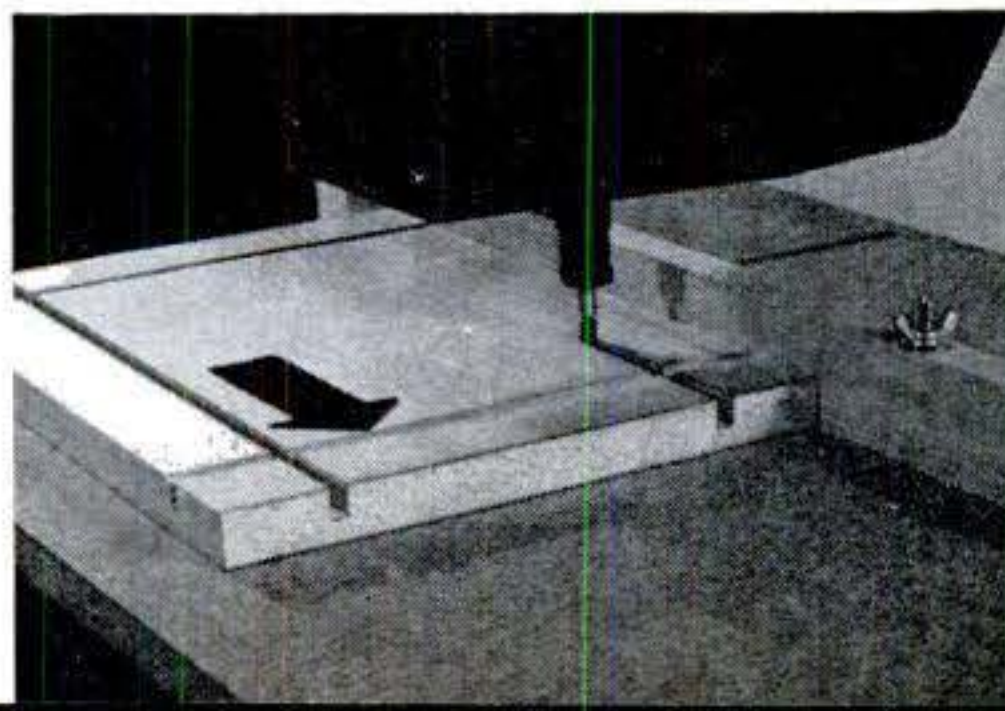


Good safety feature—machine won't run unless chuck key is in lock hole. Note speed scale does not read out in rpm.



Shaper adapter threads onto high-speed spindle to take any three-lip cutter with $\frac{1}{2}$ " hole. Adapter is an option.

Router adapter takes bits with standard $\frac{1}{4}$ " shanks. Table and fence are part of the shaper table kit—a \$16.95 option.



Toolkraft's concept of a drill press shows an awareness of the role such a tool plays in *woodworking*. All of us use the drill press for non-drilling functions like routing, shaping, drum sanding, etc., but usually we do so accepting the compromise imposed by speed limitations.

This new tool has an infinitely adjustable speed range with a low of 500 rpm and a high of 21,000 rpm. Somewhere between is the ideal speed for nearly any tool you can use in a chuck or on an adapter.

The conventional-looking three-jaw chuck setup utilizes a "lo-spindle" with a top speed of 3500 rpm—not as high as some conventional drill presses. But, no matter—turn the head 180 degrees and you bring into play a "hi-spindle" that provides a speed range of 4000 to 21,000 rpm. At those speeds, you approach optimum smoothness on routing and shaping operations.

Power is provided by a built-in GE $\frac{5}{8}$ -hp motor that turns the main drive through a gear system—no belts. Solid-state controls are behind the speed-changing mechanism; you turn a knob and a red band moves across a calibrated window to tell you the speed you should use for a particular operation.

The combination of power with various speeds that I tried for test applications worked out okay. There was no problem when drilling a max hole in steel or in hardwood (traditionally—with a $\frac{1}{2}$ " chuck— $\frac{1}{2}$ " in steel and about double that in hardwood). Of course, with spade bits and various types of circle cutters, you can go well above the stated capacity in hardwoods.

The new drill-router is available as a floor model (\$269.95) or in bench-model style. They are, of course, identical except for the length of the column. Units are made by Toolkraft Corp., 700 Plainfield St., Chicopee, Mass. 01013.

Routing and shaping adapters and accessories, as well as mortising attachments and drum sanders, are available at extra cost.

Recips: Tough Saws for Tough Work

In the shop, on the construction site,
or out in the backyard—reciprocating saws
are at home on almost any job

By A. J. HAND / *PS Home Workshop Editor*

Reciprocating saws won't make straight-line cuts as smoothly or as fast as a circular saw. They can't cut curves as well as a saber saw. And they can't prune trees or cut firewood as fast as a chain saw. But they can do all these jobs, and some that the other saws can't do. Like cutting an opening for a window or door—right through plasterboard, studs, sheathing, siding, and nails. Or flush-cutting in tight quarters. And they're pretty good power hacksaws, too. In fact, the recips are so versatile it's hard to find a plumber, electrician, or builder who doesn't own one.

Recips come in two basic forms—the skinny linears like the Rockwell or the Milwaukee Sawzall; and those with offset motors like the Sears, Montgomery Ward, or Stanley. As a rule, the linear saws are more rugged, more expensive—usually around \$100—and faster working. The offset types are about half as expensive, and seem to be designed to handle shop work—as opposed to construction work—more easily than the linears.

Matching a saw to your needs. Each of the five saws I tested had its own character, so it's possible to pick a saw to match closely the kind of work you do.

- **Rockwell Tiger Saw.** This is the saw I'd pick for roughing-in and construction work exclusively. None of the others can match its speed, and it's rugged enough to take the kind of manhandling it's sure to get from a worker using it to hack out rough openings. But this saw is such a worker, it's a little hard to control on delicate work.

- **Milwaukee Sawzall.** This two-speed saw is right behind the Rockwell in cutting speed, but it's easier to handle on light work. It's a tough saw, too, and a favorite among professional builders and plumbers. It's backed up by a tremendous assortment of blades—66 in all. That gives it real versatility.

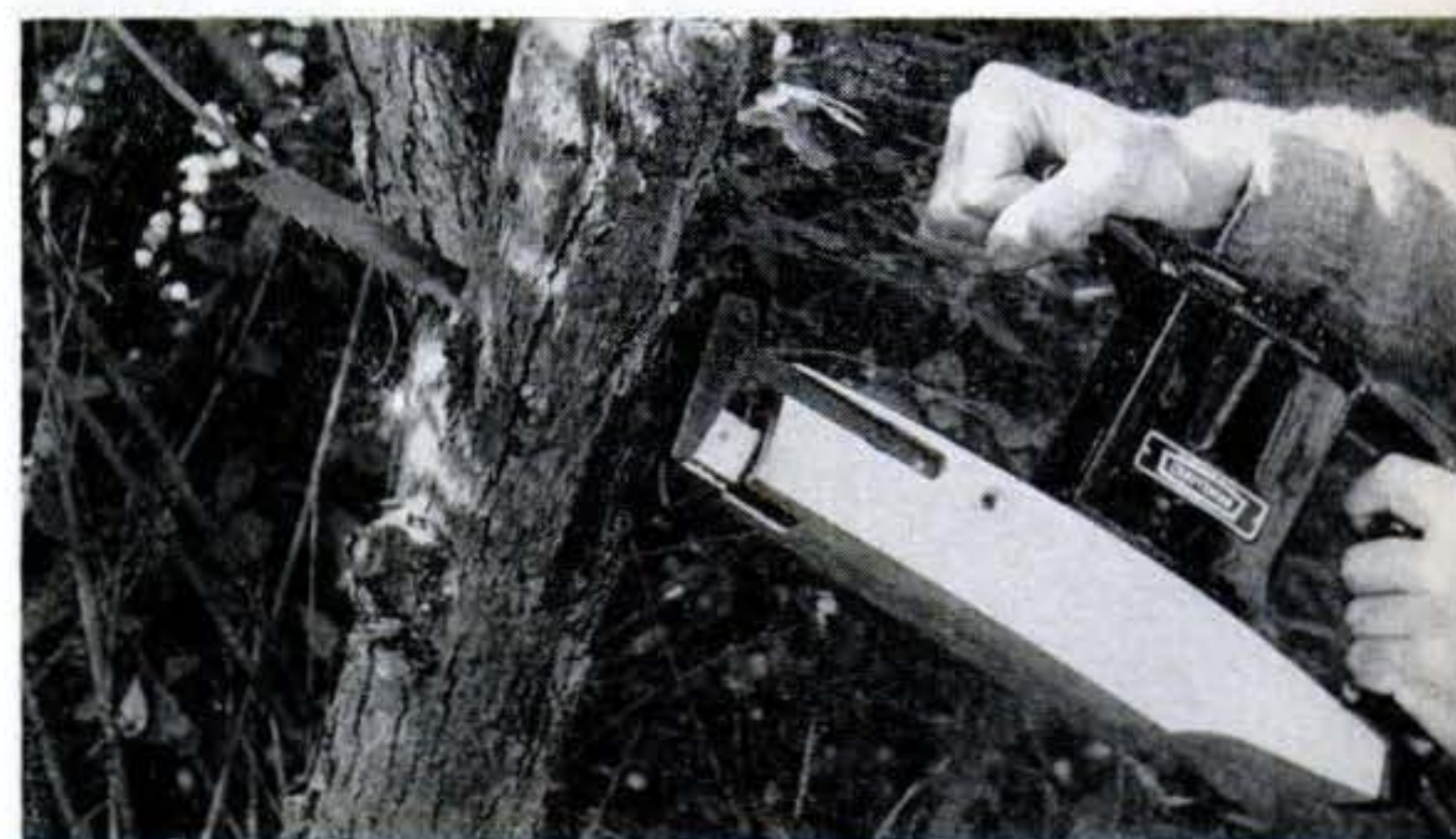
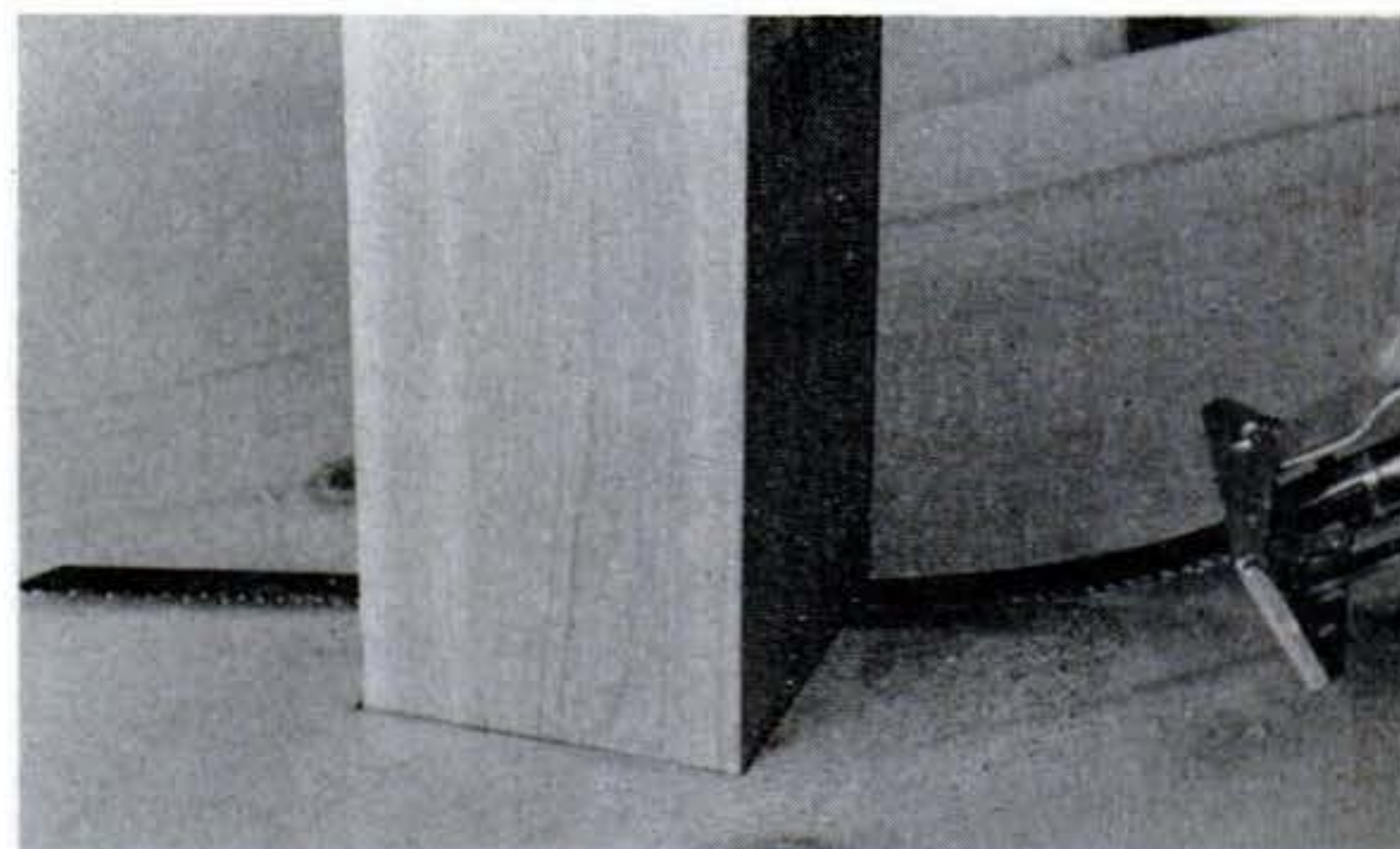
- **Sears and Montgomery Ward.** These saws handle very much alike, and they have some identical features. Both are champs at flush-cutting. They come with special blades for the job. Fasten these in place with their flathead screws, and they're dead flush with the soles of the saws. And since both saws have dead-flat soles, you can slide them along your work and get perfect flush cuts. Other saws compromise somewhat in this area. These saws also have the largest soleplates, making control a little easier. The Wards soleplate has setscrews that let you lock it at any angle up to 45 degrees for accurate bevel cuts.

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Hard-working Rockwell Tiger Saw has the guts to cut an occasional stick of firewood, but you'll need a greenwood blade from another maker. Rockwell doesn't offer one.

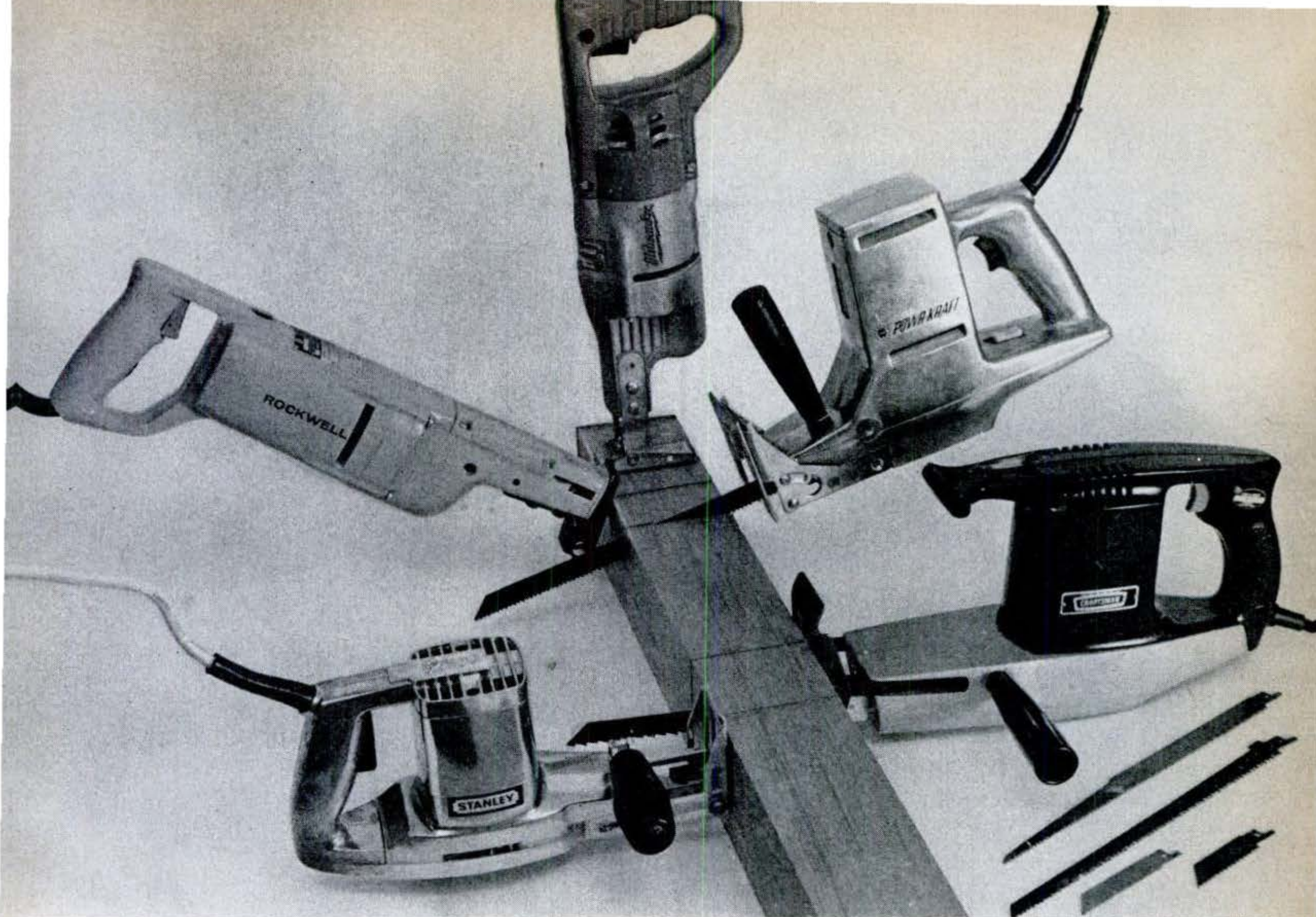
A long blade can be flexed to allow flush cuts on saws that don't offer true flush cutting (Sears and Wards do). Blades for recips take this kind of abuse in stride.



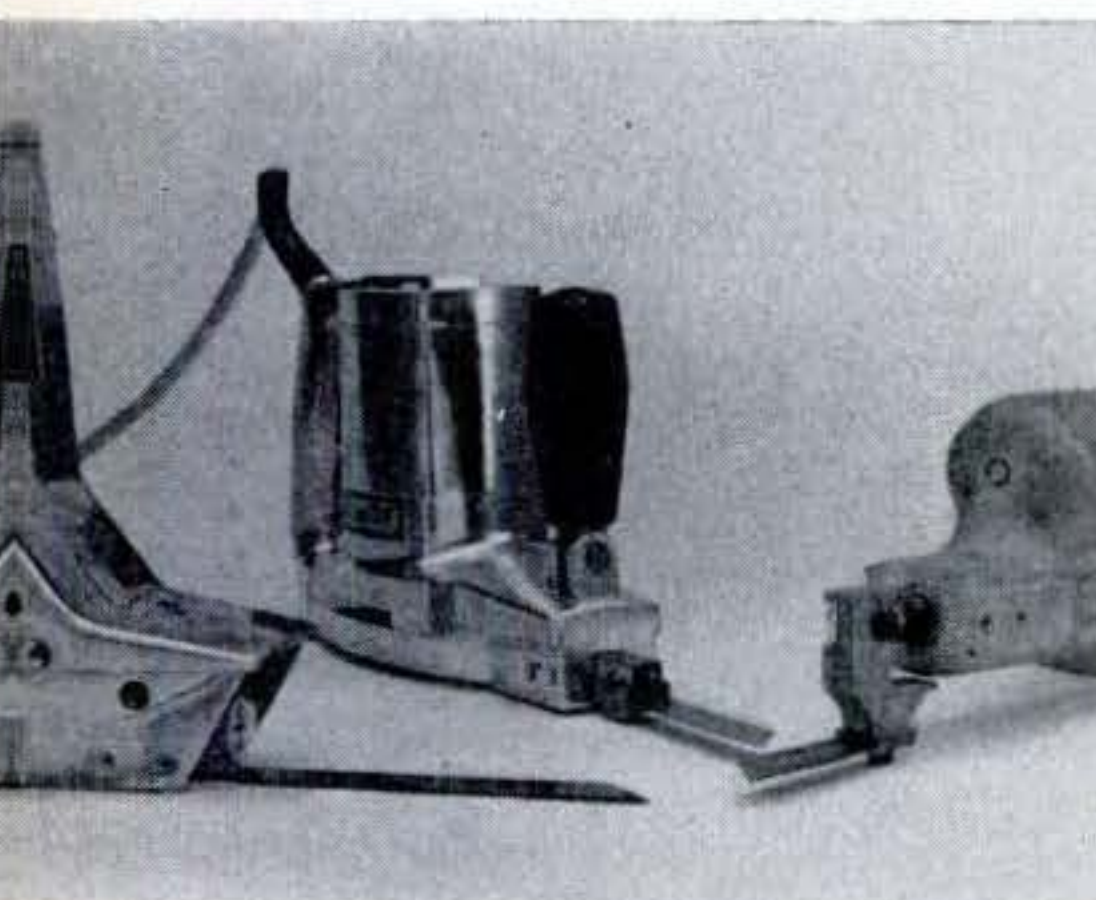
Sears saw comes with a nine-inch blade for pruning. It's double insulated, too, nice for outdoor work with extension cords. Variable-speed feature adapts it to wood or metal.

Blade-mounting tangs vary slightly from maker to maker. Differences between Wards and Sears flush-cutting blades (left) are obvious. Other blades are more nearly similar.



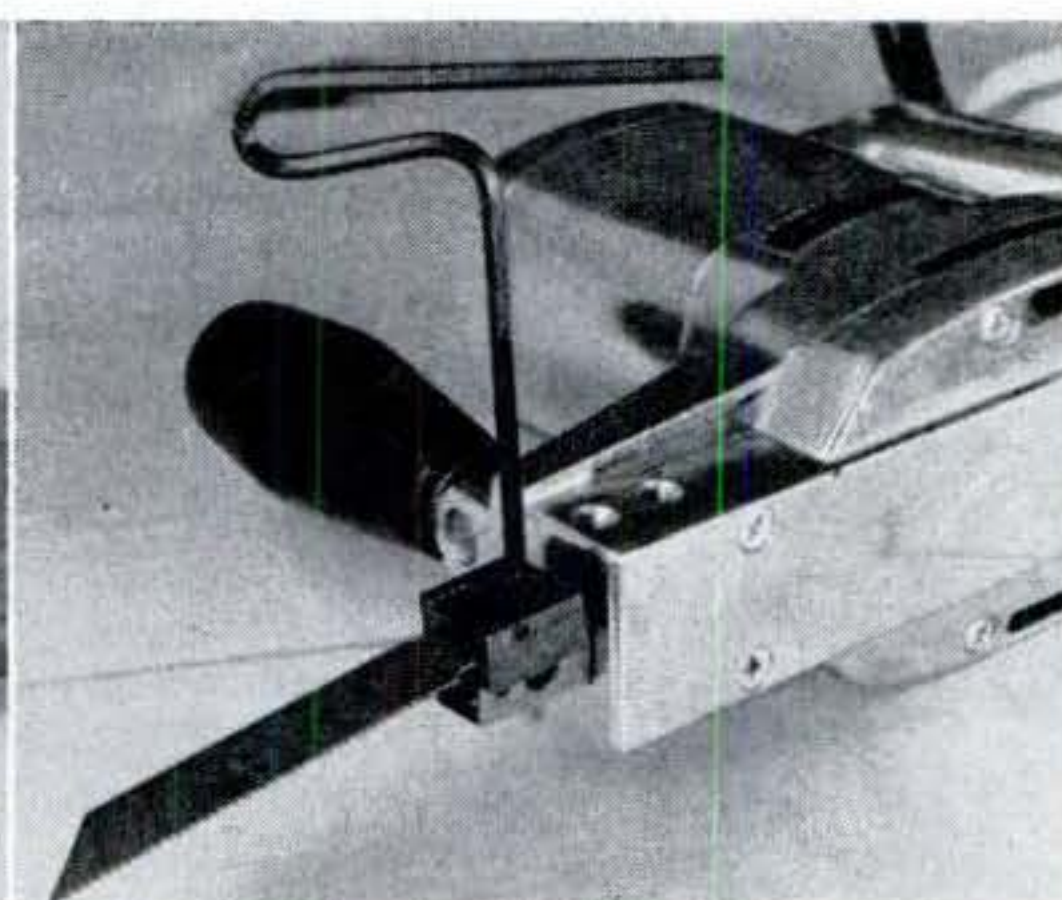


Five reciprocating saws tested by PS all had different personalities. You can pick one that's suited for your work.



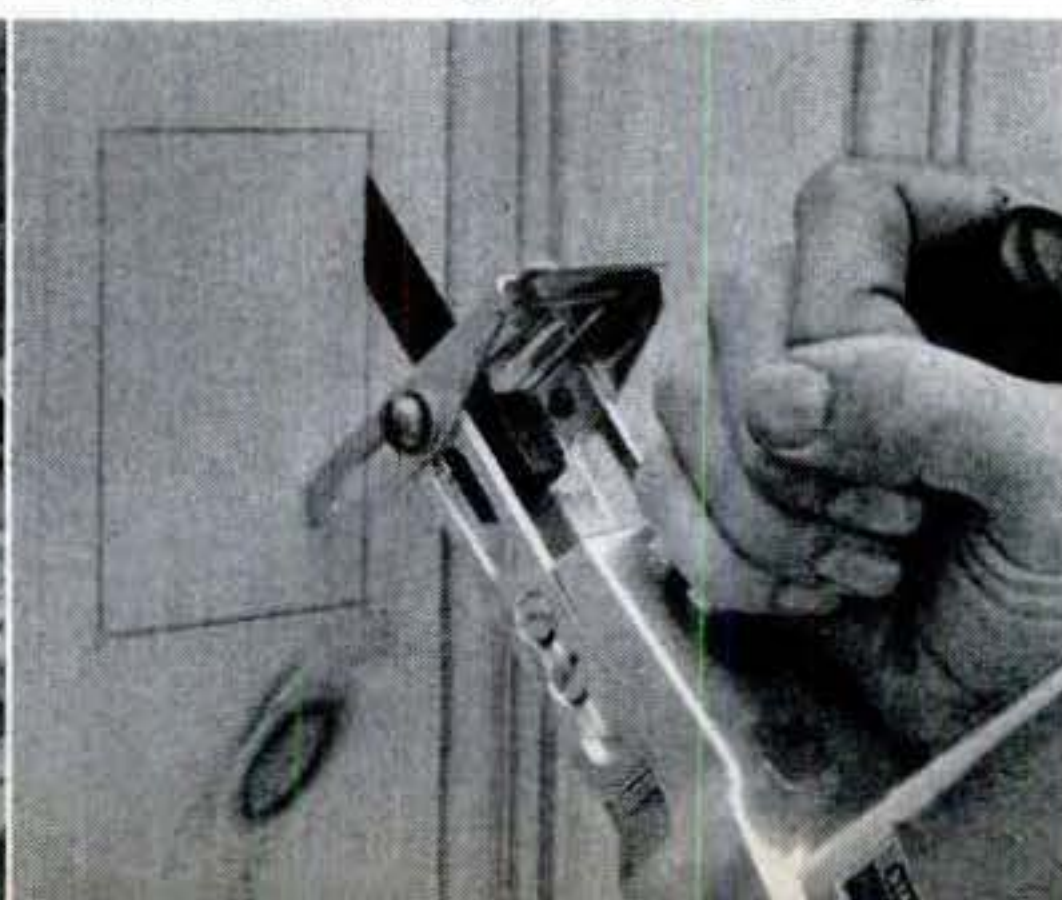
Wards flush-cutting blade mounts flush with base of tool (so does Sears). Stanley and Sawzall blades are offset.

Flush cut for a skylight is no problem with a recip. A plunge cut with Wards flush-cutting blade does the trick.



All saws secure blades via Allen-screw clamps. Blade changing is a little tedious. Soleplate is removed above.

Smooth-running Stanley does the neatest job on pocket or plunge cuts. Here the saw cuts outlet opening.



Two-speed Sawzall with a metal-cutting blade sure beats sawing by hand. Secure work firmly, press soleplate against work. Use a sharp blade.

For '74's Big Snows: Choose Your Thrower



Concentrated power is the secret to this Ariens thrower's drift-busting abilities. A big eight-horse engine clears a 24-inch path. Traction unit drives mowers and other equipment.

What size and kind of thrower do you need? Is bigger better?
Here's an expert's advice By E. F. LINDSLEY / PS Midwest Editor

If you're pushing your luck in hopes of a snowless winter, lots of luck. The odds are against it. With well over 100 snow throwers to choose from (and this doesn't cover the market completely), you can tilt the odds in your favor and practically pick a custom model for your snow situation. Knowledge is the key to a wise selection.

In spite of the huge number of makes and models, snow throwers can be pretty well classified as to size, type, and capability:

- Hand-propelled, including the super-lights such as Toro's Snow Pup and Jacobsen's Snow Blitz, Sears' and Sunbeam's cord-type electrics, Atlas and Tru-Test's 20-inchers, and a few others.

- Light-duty self-propelled, generally with four or five horsepower, a single forward speed, usually (but not always) reverse, manual start, mostly single-stage.

- Medium-duty self-propelled. Here the main difference is heavier construction, multiple forward speeds, often two-stage and electric starting available. Ariens four and

five-hp, for example, fit this class, since in spite of power and size they are definitely not light-duty.

- Heavy-duty self-propelled. The seven and eight-hp models are the top of the lines and scoop widths are 24", 26", 28", and 32". Caution is advised when buying in this range; we'll explain why later.

Like most outdoor power equipment, snow throwers are at a point of mature engineering. So far, no one has invented a dramatically "better way." But we noted many little improvements and a few major changes. Among them:

- Allis-Chalmers and Homelite designs for space-saving, nose-stand storage in off season.

- Atlas and Lambert with novel sawtooth auger edges and unusual contours that should help when biting into hard-packed snow or car-track ridges.

- Roper, with a dual front auger on their big eight-hp model.

- Eska's built-in chute cleaner. It's claimed there's no need for shut-down and poke-out; just flip the chute from side to side.

- Yardman's Super-Chute, which is essentially a means of turning the discharge chute's point of tangency with the impeller to minimize changes of direction for the discharged snow. We've tried a similar design on a big Gravely tractor-mounted unit and it works great.

Don't buy oversize. If you're inclined to buy your cars, boats, and lawn tractors with just a little desire to impress your friends and neighbors, squelch such impulses when buying a snow thrower. Buy on cold engineering facts, your real needs, and your physical condition.

The little lightweights can be a boon if your snowfall is normally only four or five inches on a short sidewalk or drive. The "shovel" types can also break up drifts the big lunkers can only growl at. Light-duty machines are not big-area machines, but they can be "tough area" tools, and they pose minimal storage problems. One of the best bets for a man with a small storage space is Gilson's four-hp, 18-incher. It will store in a garage next to your car with no squeeze.



John Deere's huge 16-inch tires give you solid traction and easy handling on all surfaces. Smaller wheels tend to hang up on old snow or rough gravel drives.



Bolens 26-incher has limited-slip differential, four speeds forward and one reverse. Controls are big and right up front where they should be for safety.



International Harvester's 328 is a big machine for big snows. It cuts a 32-inch path. Massive wide-set handles and big controls help you handle it.



Wheel Horse 26-incher has a differential drive you can lock out for more power on heavy going through a straight run. Take your pick of five or seven hp.



Homelite S-4 is just right for a small lot. Front-stand storage saves garage space. Drive? One speed forward, and one reverse for backing out of trouble.



Gilson's 18-inch model will store right beside your car—even in a narrow garage. A four-horse engine drives through two-stage thrower mechanism.

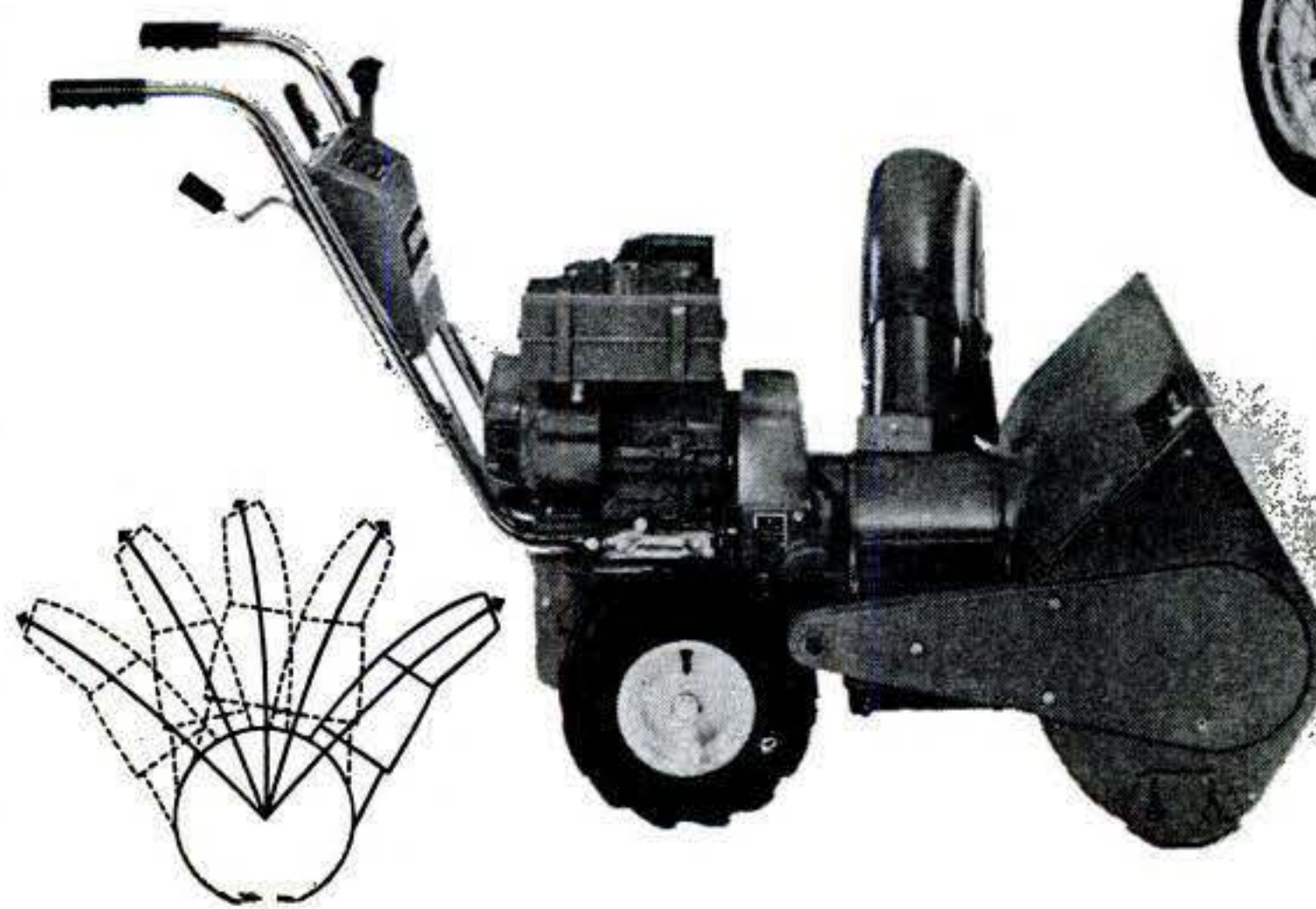
How big is good? If your region seldom sees snows of over six inches and your drifts seldom top out at over two feet, you'll be happy with the big 28" and 32" units. They cover tremendous areas rapidly because of their scoop width. If you operate on hard, paved surfaces with no pack-snow base, you'll be even happier, for these big ones are heavy and prone to dig in their wheels on rough, rutted, rock and gravel drives.

On the other hand, if you frequently must fight your way into snow that is blown, packed, and frozen over two feet on the level, and if you commonly look at your driveway and see drifts five and six feet high, be wary of superwide scoops. Long experience in trying many sizes and makes of snow throwers in deep, stubborn Wisconsin blizzard-driven drifts has taught me one thing. The ratio of horsepower to scoop entrance size is all-important! Be assured you are not going to walk through this type of snow with any machine on the market. Inevitably you must ease in, back out, hack and ram to get through a drift. A narrow scoop

with big power has far greater penetration ability than the same power applied to a 32" scoop. Note that Ariens, pioneers in snow throwers, offers eight hp on a 24" scoop. They know what it's all about. The same applies to Wisconsin Marine with seven hp on a 24" scoop.

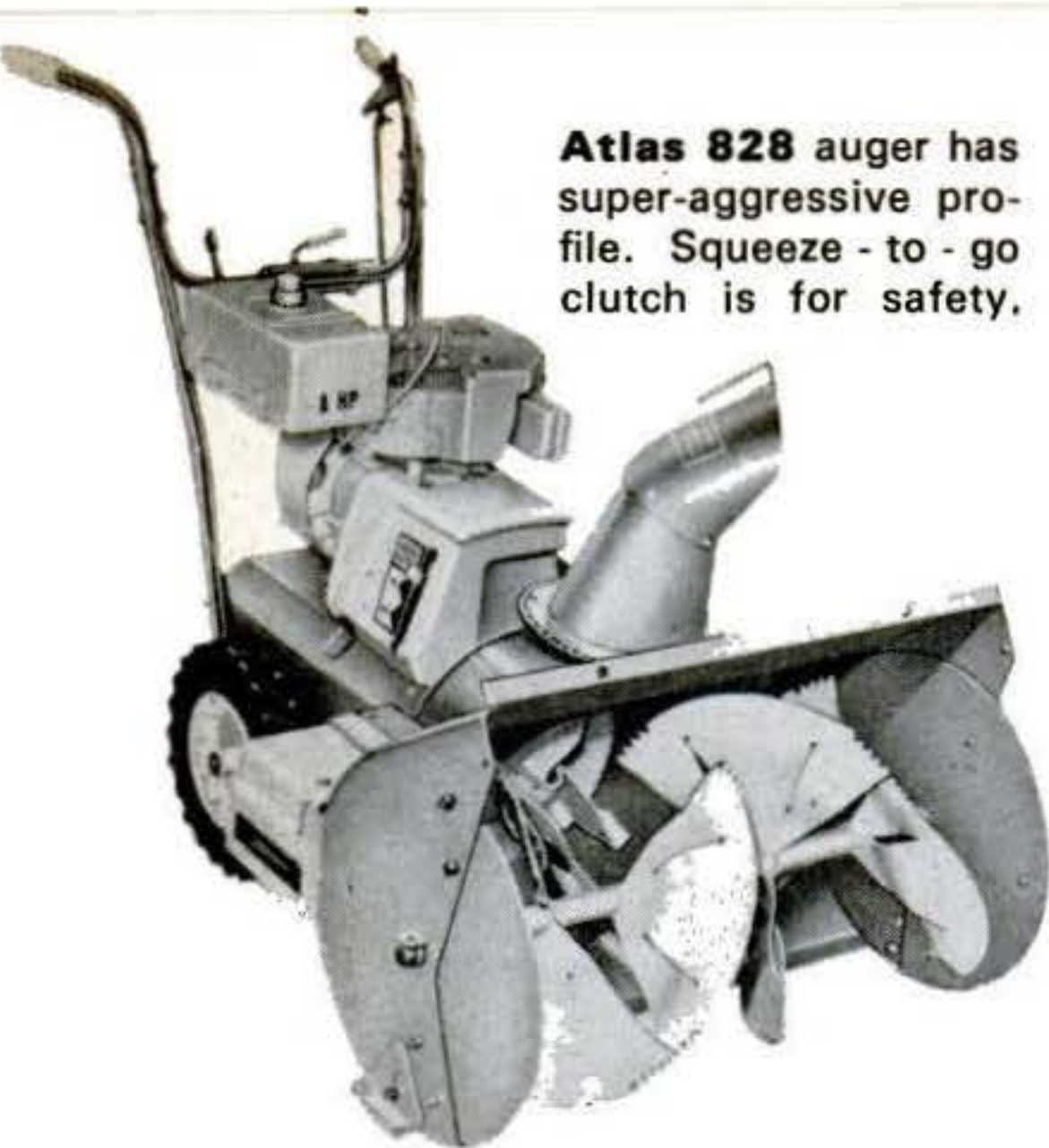
Sometimes features that seem secondary on the showroom floor can loom large when you're fighting

Continued



Cotter's Tru-Test is a low-cost, hand-push unit. If your sidewalk and drive are short, and local snowfall light, this three-hp job is a suitable choice.

Super - Chute by Yardman picks up snow in a straight shot off the impeller to stop clogs. Chute swings in synchronized action as it pivots right and left.



Atlas 828 auger has super-aggressive profile. Squeeze-to-go clutch is for safety.



Better than shoveling steps, Toro's little Sno Pup is great for tight spots. It

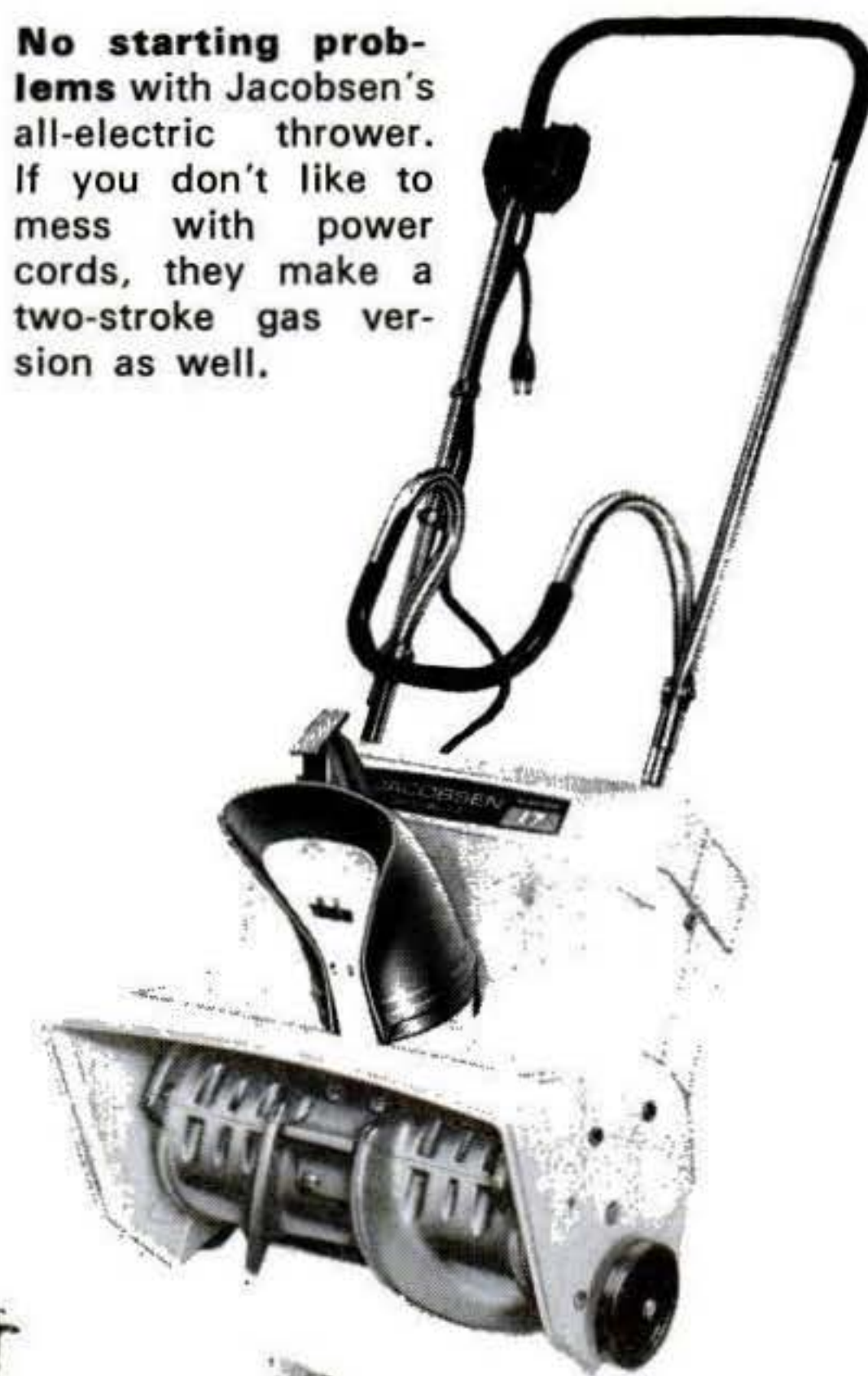
will also break a trail for bigger machines when drifts are big.



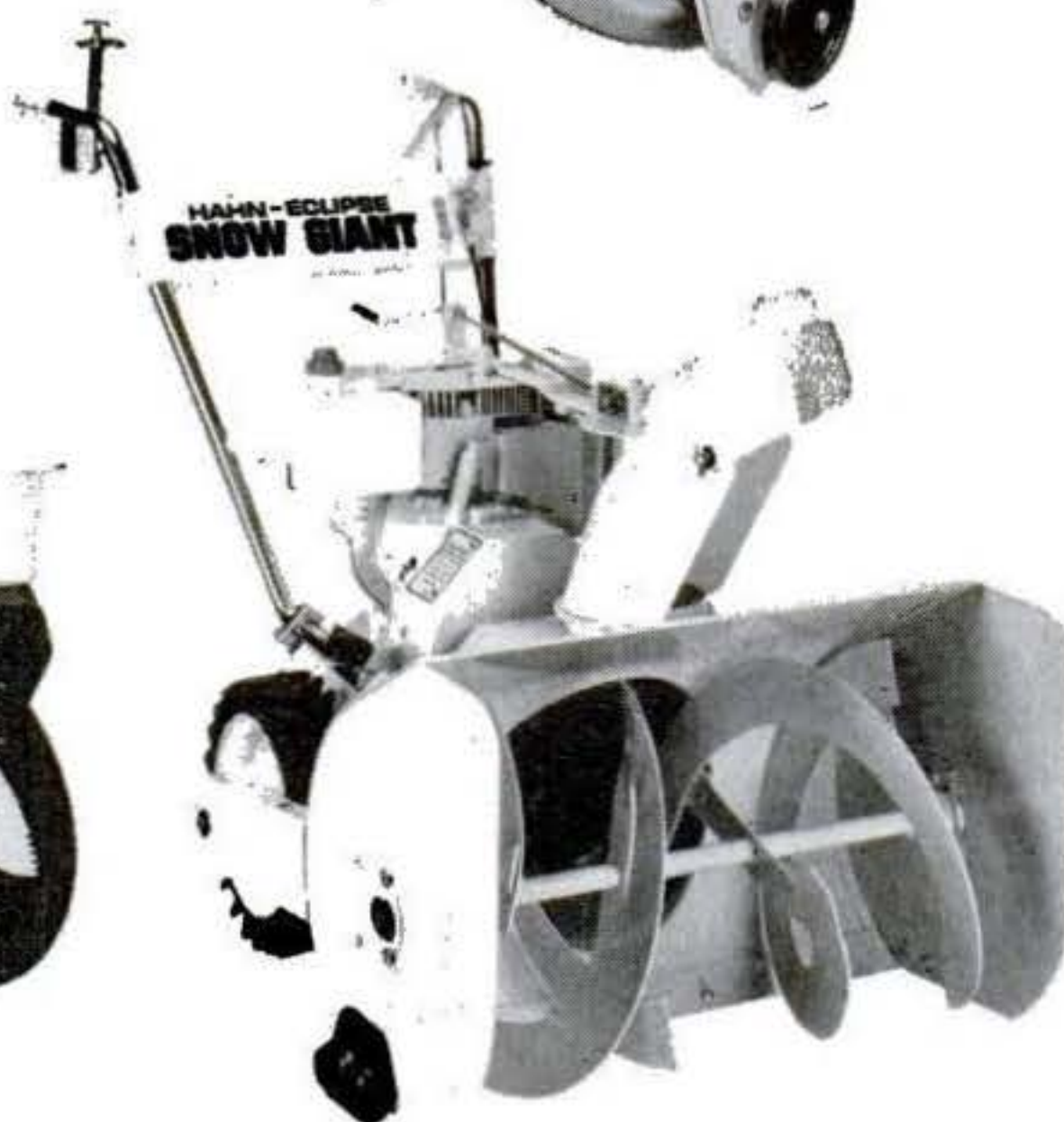
Allis-Chalmers big eight-hp rig with 28-inch cut is a nice combination of power and size. Note the large tires. Machine will store off-season on its nose.



Hinged drift breaker atop this Lambert scoop gives you something extra to break crusted snow. The 28-inch thrower has eight hp and two-stage mechanism.



No starting problems with Jacobsen's all-electric thrower. If you don't like to mess with power cords, they make a two-stroke gas version as well.



Hahn-Eclipse scoop and guide skid are smartly rigged to bite under snow, not ride over it. Auger reverses to clear when you reverse the machine.

drifts in bitter cold with thrown snow stinging your face. If you must cope with such conditions, look for:

- **Power reverse**—an absolute must for big jobs but not always vital for sidewalks.

- **Deadman clutch.** If you clear snow long enough, sooner or later you'll fall. Grip-and-go clutching stops the machine instantly so it doesn't back over you or amble out into street traffic.

- **Independent auger and wheel drive.** Tough drifts require all the power you can get on the auger at zero forward speed.

- **Electric start.** It's worth every cent at zero degrees with a big engine that hasn't run for a year.

- **Big, fat controls** right up front where you can get at them. With mittens, in the dark and with snow in your eyes, you need fumble-free handles.

Tire size, too, can mean the difference between easy going and a gasping, tugging, wrestling match with your machine. On a cleared sidewalk, small, solid rubber tires are fine, but over previously compacted snow or a graveled drive, such tires dig and bury themselves in little pockets and must be bulled free. On the big throwers look for at least 12" tires, better 13" and fat. John Deere, with its background in farm equipment, uses 16" tires. So does McDonough Snapper. Others should take note. Also, chains, standard on all Sear's self-propelleds, are extremely useful on almost any machine.

You'll find many detail features presented as selling points. Their worth is for you to decide in the light of your needs, but here are a few to know about:

- **Free-wheeling.** If you have to push and pull your thrower to and from a storage spot, it's handy to be able to free the wheels so you can

PS Guide to the '74 Snowthrowers—take your pick from over 100 models

MAKER OR SELLER	MODEL	CUT WIDTH	STAGES	HP	SELF-PROP?	FWD SPEEDS	REVERSE?	ELECT START AVAILABLE	APPROX PRICE
ALLIS-CHALMERS	TRACKER 4	21"	1	4	yes	1	yes	yes	\$300
	TRACKER 8	28"	2	8	yes	3	yes	yes	470
AMF WESTERN TOOL DIV.	HUSKY 1359	26"	2	5	yes	4	yes	yes	390
	HUSKY 1360	20"	1	4	yes	1	no	no	240
	HUSKY 1361	26"	2	8	yes	4	yes	yes	440
	HUSKY 1362	26"	3	8	yes	4	yes	yes	490
ARIENS	4-hp	20"	2	4	yes	4	yes	yes	300
	5-hp	20"	2	5	yes	4	yes	yes	330
	6-hp	24"	2	6	yes	4	yes	yes	360
	6-hp	24"	2	6	yes	4	yes	yes	400
	8-hp	24"	2	8	yes	4	yes	yes	430
	8-hp	32"	2	8	yes	5	yes	yes	470
ARCTIC ENTERPRISES	726	26"	2	8	yes	4	yes	yes	410
	832	32"	2	8	yes	4	yes	yes	460
ATLAS TOOL & MFG.	SN320	20"	1	3	no			no	150
	SN520	20"	1	5	yes	1	no	no	205
	ESN524	24"	1	5	yes	1	no	yes	270
	SN828	28"	2	8	yes	7	yes	yes	460
BOLENS DIV., FMC CORP.	524	24"	2	5	yes	4	yes	yes	380
	726	26"	2	7	yes	4	yes	yes	420
	832	32"	2	8	yes	4	yes	yes	470
COLUMBIA, MTD PROD., INC.	101-3	18"	1	3	no			no	150
	231-3	20"	1	5	yes	1	yes	yes	270
	551-3	23"	2	5	yes	1	yes	yes	380
	831-3	26"	2	8	yes	6	yes	yes	450
COTTER & CO. TRU-TEST	T401A	20"	1	3	no			no	120
	T404A	20"	1	5	yes	1	no	no	170
	T504BE	24"	1	5	yes	1	no	yes	210
DEERE & CO.	526	26"	2	5	yes	4	yes	yes	405
	726	26"	2	7	yes	4	yes	yes	440
	832	32"	2	8	yes	4	yes	yes	475
	957	20"	1	4	yes	1	no	no	230
ESKA COMPANY	945	20"	1	5	yes	1	yes	yes	310
	941	20"	1	5	yes	1	yes	yes	320
	952	26"	1	8	yes	1	yes	yes	430
	952	26"	1	8	yes	1	yes	yes	430
GILSON BROS. CO.	55008	18"	2	4	yes	1	yes	no	290
	55010	26"	2	5	yes	3	yes	yes	420
	55011	26"	2	5	yes	3	yes	no	365
	55016	26"	2	8	yes	3	yes	yes	445
	55012	28"	2	8	yes	3	yes	yes	465
HAHN-ECLIPSE CO.	CH-584-5	24"	2	5	yes	4	yes	no	360
	LH-584-5	24"	2	5	yes	4	yes	yes	380
	UH-584-7	24"	2	7	yes	4	yes	yes	425
	UH-586-8	26"	2	8	yes	4	yes	yes	450
HOMELITE	S-4	21"	1	4	yes	1	yes	no	299
	S-8	28"	2	8	yes	3	yes	yes	500
INTERNATIONAL HARV.	265	26"	2	5	yes	4	yes	no	365
	268	26"	2	8	yes	4	yes	yes	438
	328	32"	2	8	yes	4	yes	yes	450
JACOBSEN	SNO-BLITZ 17	17"	1	2	no			no	NA
	SNO-JET	20"	1	3.5	yes	1	no	no	255
	IMPERIAL 26	26"	2	5	yes	4	yes	yes	380
	IMPERIAL 26	26"	2	7	yes	4	yes	yes	425
	IMPERIAL 30	30"	2	8	yes	4	yes	yes	470
LAMBERT	HS-1520	20"	1	5	yes	1	yes	no	230
	HS-1524	24"	1	5	yes	5	yes	no	330
	HS-2524	24"	2	5	yes	7	yes	no	425
	HS-2828	28"	2	8	yes	7	yes	no	460
	HS-2828-SE	28"	2	8	yes	7	yes	yes	500

MAKER OR SELLER	MODEL	CUT WIDTH	STAGES	HP	SELF-PROP?	FWD SPEEDS	REVERSE?	ELECT START AVAILABLE	APPROX PRICE
LAWN BOY, DIV. OMC	1840	18"	2	4	yes	1	yes	no	\$285
	2650B	26"	2	5	yes	3	yes	no	365
	2680B	26"	2	8	yes	3	yes	yes	445
McDONOUGH POWER EQUIP.	SN501	26"	2	5	yes	4	yes	yes	395
	SN801	26"	2	8	yes	4	yes	yes	440
MASSEY-FERGUSON	MF227	26"	2	7	yes	4	yes	yes	419
	MF228	26"	2	8	yes	4	yes	yes	439
MTD PRODUCTS, INC.	313-100	18"	1	3	no			no	NA
	313-205	20"	1	3.5	yes	1	yes	no	NA
	313-230	20"	1	5	yes	1	yes	yes	NA
	313-430	21"	1	5	yes	1	yes	yes	NA
	313-550	23"	2	5	yes	1	yes	yes	NA
	313-570	23"	2	7	yes	1	yes	yes	NA
	313-830	26"	2	8	yes	6	yes	yes	NA
	313-830	26"	2	8	yes	6	yes	yes	NA
J. C. PENNEY	4010	20"	1	5	yes	1	no	no	200
	4020	24"	1	5	yes	5	yes	yes	300
	4030	24"	2	5	yes	7	yes	yes	400
	4040	28"	2	8	yes	7	yes	yes	500
	4040	28"	2	8	yes	7	yes	yes	500
ROPER SALES CORP.	614M	20"	1	4	yes	1	no	no	260
	635M	20"	1	5	yes	1	yes	yes	340
	637M	22"	1	7	yes	1	yes	yes	380
	638M	24"	3	8	yes	2	yes(2)	yes	480
SEARS	ELECTRIC	18"	1	2.1	no				150
	CRAFTSMAN 20	20"	1	4	yes	1	no	no	200
	CRAFTSMAN 20	20"	1	5	yes	1	yes	yes	300
	CRAFTSMAN 24	24"	2	7	yes	4	yes	yes	390
	CRAFTSMAN 26	26"	2	8	yes	4	yes	yes	440
SIMPLICITY	558	21"	1	4	yes	1	yes	no	295
	869	24"	2	5	yes	2	yes	yes	383
	870	26"	2	7	yes	2	yes	yes	434
	796	28"	2	8	yes	2	yes	yes	465
	796	28"	2	8	yes	2	yes	yes	465
SUNBEAM OUTDOOR CO. (ALL ELECTRIC)	SE-161	20"	1	3	no				85
	SE-165	20"	1	3	no				100
	SE-185	18"	1	3	no				160
	SE-229	22"	1	3	no				180
TORO	SNOW PUP 14	14"	1	2	no			no	130
	SNOW PUP 21	21"	1	2.5	no			no	145
	31304	20"	1	3.5	yes	2	yes	no	240
	31624	24"	2	5	yes	3	yes(2)	yes	380
	31677	24"	2	7	yes	3	yes(2)	yes	420
	31763	26"	2	7	yes	3	yes	yes	470
	31823	32"	2	8	yes	3	yes	yes	520
	31823	32"	2	8	yes	3	yes	yes	520
WARDS	470B	18"	2	4	yes	1	yes	no	240
	474A	20"	2	4	yes	1	yes	no	252
	478E	20"	2	5	yes	1	yes	no	324
	472D	26"	2	5	yes	3	yes	yes	369
	490E	26"	2	7	yes	3	yes	yes	389
	476E	26"	2	8	yes	3	yes	yes	409
WHEEL-HORSE PROD.	TRAILBLAZER	26"	2	5	yes	2	yes(2)	yes	NA
	TRAILBLAZER	26"	2	7	yes	2	yes(2)	yes	NA
	TRAILBLAZER	26"	2	7	yes	2	yes(2)	yes	NA
WIS. MARINE	BOBCAT	20"	2	5	yes	1(2)	yes	yes	NA
	BOBCAT	24"	2	7	yes	1(2)	yes	yes	NA
	BOBCAT	28"	2	8	yes	2	yes	yes	NA
YARDMAN, INC.	7160	22"	2	4	yes	1	yes	yes	290
	7090	24"	2	5	yes	5	yes	yes	370
	7100	26"	2	7	yes	5	yes	yes	430
	7200	30"	2	8	yes	5	yes	yes	485

Note: all engines four-cycle except Columbia 18", Jacobsen 17" (electric model available) and 20", and Toro Sno Pups.

push without turning the drive train.

- Differential lockout. For normal turns in easy going, a differential makes handling easier. In hard, straight-on drift fighting it helps to have a solid axle. Lawn Boy has an individual feature, here; others have similar arrangements.

- Multiple forward speeds. For the real snow country, we'd deem this extremely important. A single-speed drive is really practical only in light cleaning.

- Heavy structure. Snow throwers take much abuse, and the impor-

tance of a husky handle structure cannot be overstressed.

Unless you're an old hand with snow throwers, you may not be familiar with such nice details as the placement of the scoop-scraper edge bar relative to the auger and the skid adjustments. Hahn-Eclipse, for one, has done some special things with auger side shields and skid placement—the latter to help prevent the scoop from riding up over hard spots. To understand this, before buying, try adjusting the guide skids to raise the scoop lip about

1½" above the surface. If this causes the cutter edge and scoop bottom to angle upwards, you'll have a bad time keeping the machine from climbing upward over hard spots in the snow. Better geometry provides a level or slight scraping action so the scoop will shave and lift the snow into the auger.

Use the table above. First select a number of machines in your size and power bracket. Do not be guided by price but by your needs and the further details you can determine from the maker's literature. **PS**



Add Shimmer to Your Christmas Lights

By RUDOLF F. GRAF and GEORGE J. WHALEN

About to decorate that Christmas tree? If you have a couple of hours to spare, here's a simple project to really spruce up the old spruce. Just plug your light string into this Shimmerlite box and your tree lights gain an added strobe—or shimmer—effect. They pulse at any rate you wish, from a medium glow to a bright strobe-like flash. Blinking lights? Add Shimmerlite to these, and they'll not only flicker, but have added shimmer as well. And, you can use Shimmerlite to control outside lights, too.

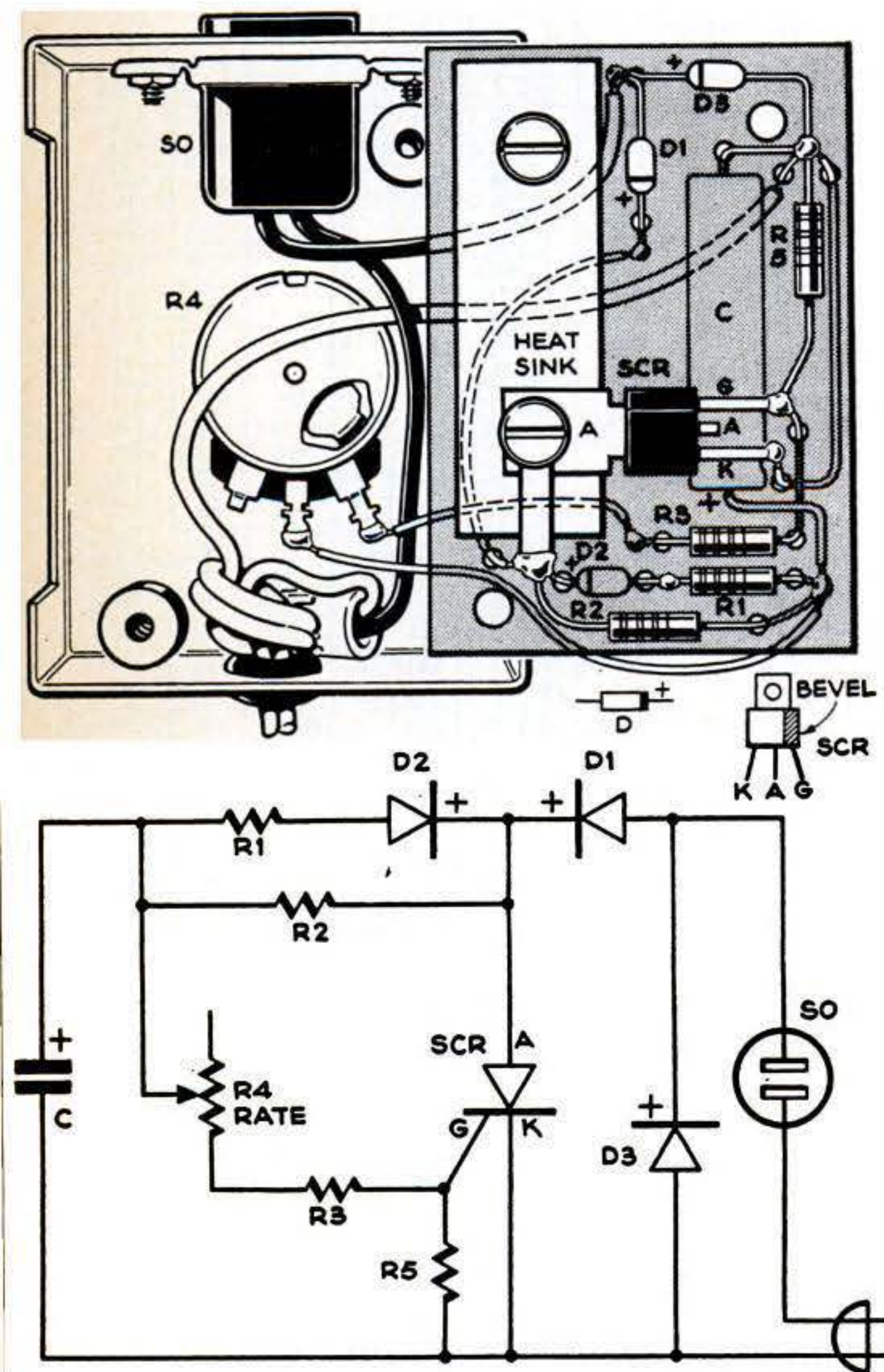
The Shimmerlite circuit uses one-half of the AC cycle from your house current to power the lights ordinarily. But, as the timing circuit capacitor charges, voltage on the gate of the SCR builds. Then, when it reaches the firing point, the SCR conducts, allowing the other half of the AC cycle to pass through to the light string. The result: a quick "shot" of normal house current giving the strobe effect.

You can easily fit the components for the Shimmerlite into a 1½"-by-2"-by-2¾" aluminum minibox. All parts, except the line socket and variable control, R4, are mounted on a piece of perforated circuit board. One-inch spacers support the board inside the box.

The SCR is mounted on a heat sink (made from scrap metal) to conduct heat away from the device. And—as the drawing shows—the mounting tab makes the connection for the anode pin (pin and tab are connected internally in the SCR). Because of this, be sure the heat sink does not touch the metal spacers or the box, once the cover is in place. Component leads are soldered directly together and no board pins are necessary. Use 20-gauge hook-up wire for the interconnections and keep them as short and neat as possible. For a more dramatic effect, you can build two or more Shimmerlites connecting each to a separate string of lights. Each will flash at different rates and at different times.

If you wish to use Shimmerlite on an outside set of lights and cannot keep the box indoors, build the circuit in a water-tight container and do not leave the socket and control potentiometer exposed. Water can play havoc with circuitry—not to mention causing shocks.

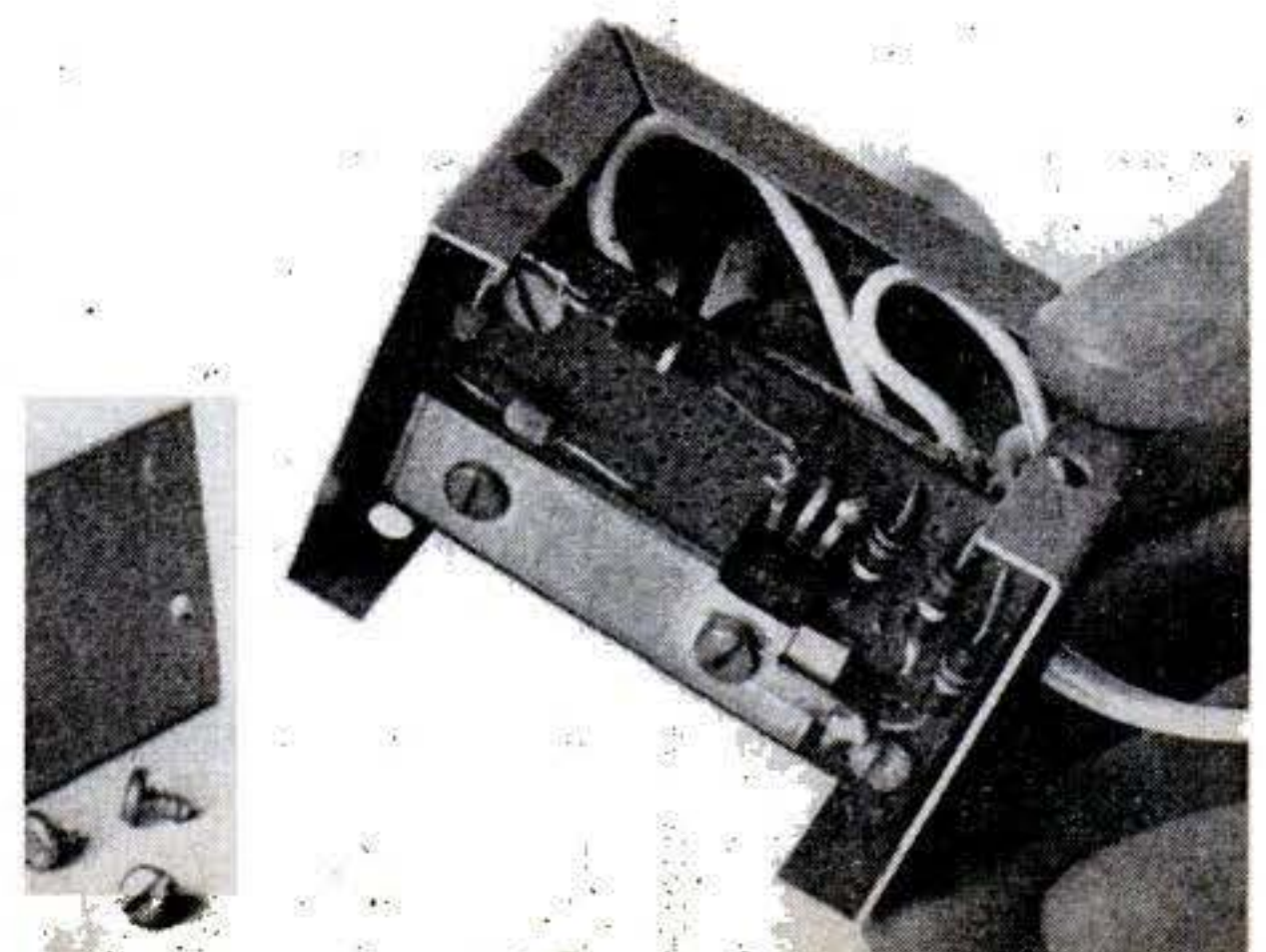
One of the best features of the device is its small size. When it comes time to pack up the decorations until next year, Shimmerlite will fit in with your other accessories. **PS**



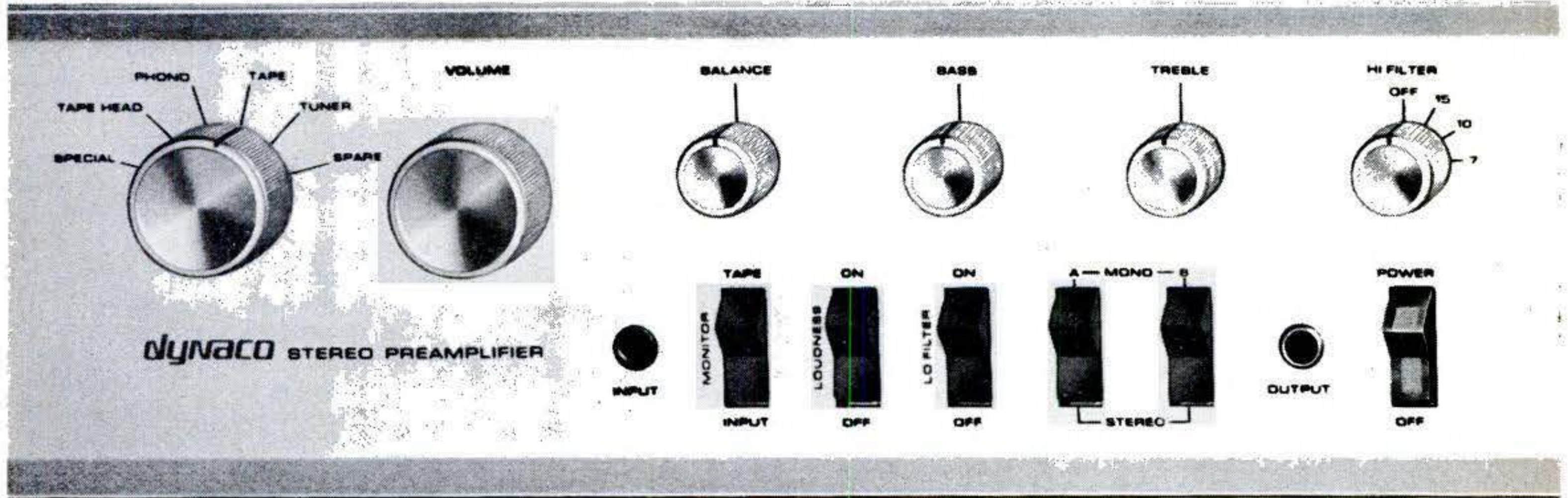
PARTS LIST

- | | |
|--------------------------------------|--|
| C—100ufd @50v electrolytic capacitor | R5—1000-ohm, ½w resistor |
| R1—2700-ohm, ½w resistor | D1,2,3—Diode, Motorola HEP R0053 |
| R2—22,000-ohm, ½w resistor | SCR—Silicon-controlled rectifier, GE C106B1 or Moto. HEP R1221 |
| R3—3300-ohm, ½w resistor | SO—Line socket |
| R4—100,000-ohm potentiometer | Misc.—Line cord, cabinet |

Open-end view of Shimmerlite shows perforated board mounted above R4 and AC socket on spacers. Ground lug on SCR tab provides anode connections. Keep wiring short and take care not to pinch insulation when box top is screwed in place.



When you want the very best stereo without paying the highest price

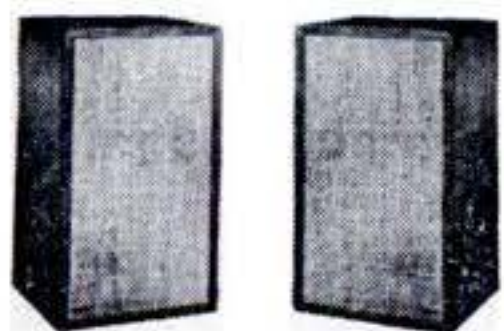


PAT-4 Preamplifier

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Shop Talk

News and views of tools and materials
By AL LEES

Eight for under the tree: books for the do-it-yourself family

Sampled below: representative books, sent me for review in recent weeks, that offer a broad selection of gift possibilities for members of an active, project-oriented family. To keep your wife busy while you disappear into the shop these long winter evenings, there's a striking new series of crafts books called *Golden Hands*, with concise directions and diagrams for making the items that are displayed in big color photos. My pick of the half-dozen titles in the series thus far is *Handcrafts* (1) covering everything from weaving to leathercraft. Other titles: *Bargello*, *Embroidery*, etc.; \$4.95 each, Random House. Or buy your wife No. 6: over 500 pages of tips and data on home decorating by interior designer Bette Bragg; Branden Press, Boston; \$12.50—high for a book without photos, but it's peppered with how-to sketches. If you're house-hunting, give yourselves No. 7: Each chapter discusses a different problem that can plague the unwary; send \$3.30 to All About Houses, Piermont, N.Y. 10968. Got a longhair home for the holidays? If he flipped for our July article on making an inflatable dome, buy him the book of plans, formulas, and materials sources we mentioned there (2); it's a unique compendium of data on do-it-yourself air domes; \$5 from Poor Willie, 539 Tremont St., Boston, Mass. 02116. Two books are on working with plastic: No. 5 gives basic instructions and many specific plans for handsome projects of acrylic sheet (\$6.95, Simon & Schuster); No. 8 offers the young model-maker detailed instructions for improving commercial kits (\$2.95, Ballantine). Nos. 3 and 4 are new editions from Audel—the daddy of how-to publishers—\$9.95 and \$10.50, respectively. Both are so packed with data essential to home maintenance that they call for the separate review at right.

Two from the bible house

Audel has been synonymous with instructional books for generations. Two fat volumes bearing that proud name (see photo, far left) are of particular interest to responsible homeowners. Audel recently came out with a new edition of its 950-page bible, *Millwrights and Mechanics Guide* by Carl A. Nelson.

Though aimed at plant workers, the book makes a fine reference source for home maintenance, as well. A chapter on electricity, for example, is a clear review of basics, with diagrams to explain the function of circuits, of AC motors, of DC generators.

Other chapters mix charts, diagrams and photos in covering such devices as pumps, valves, compressors, bearings, belt-drives and gears, and such skills as mechanical drawing, sheet-metal work, welding, and carpentry (this new edition should have updated its table of lumber sizes). It contains a 28-page appendix of machinists' standards.

Of more general application to the home shop is Audel's *Do-It-Yourself Encyclopedia*—a hefty 1000-page alphabetized reference source for virtually every home-improvement and maintenance job. It's well organized, and includes a wealth of illustrations; but for a new book, too many of the photos have a dated look. Audel's address: P.O. Box 558, Indianapolis 46206.

That new yardstick isn't just coming—it's already here

One of last month's articles on going metric was titled: "Here Comes the New 'Yardstick' . . ." Already available is Lufkin's "metre stick" (below): 39-plus inches of aluminum with dual scales on one side and, on the other, tables of two-way equivalents and conversions. It retails for \$2.65.

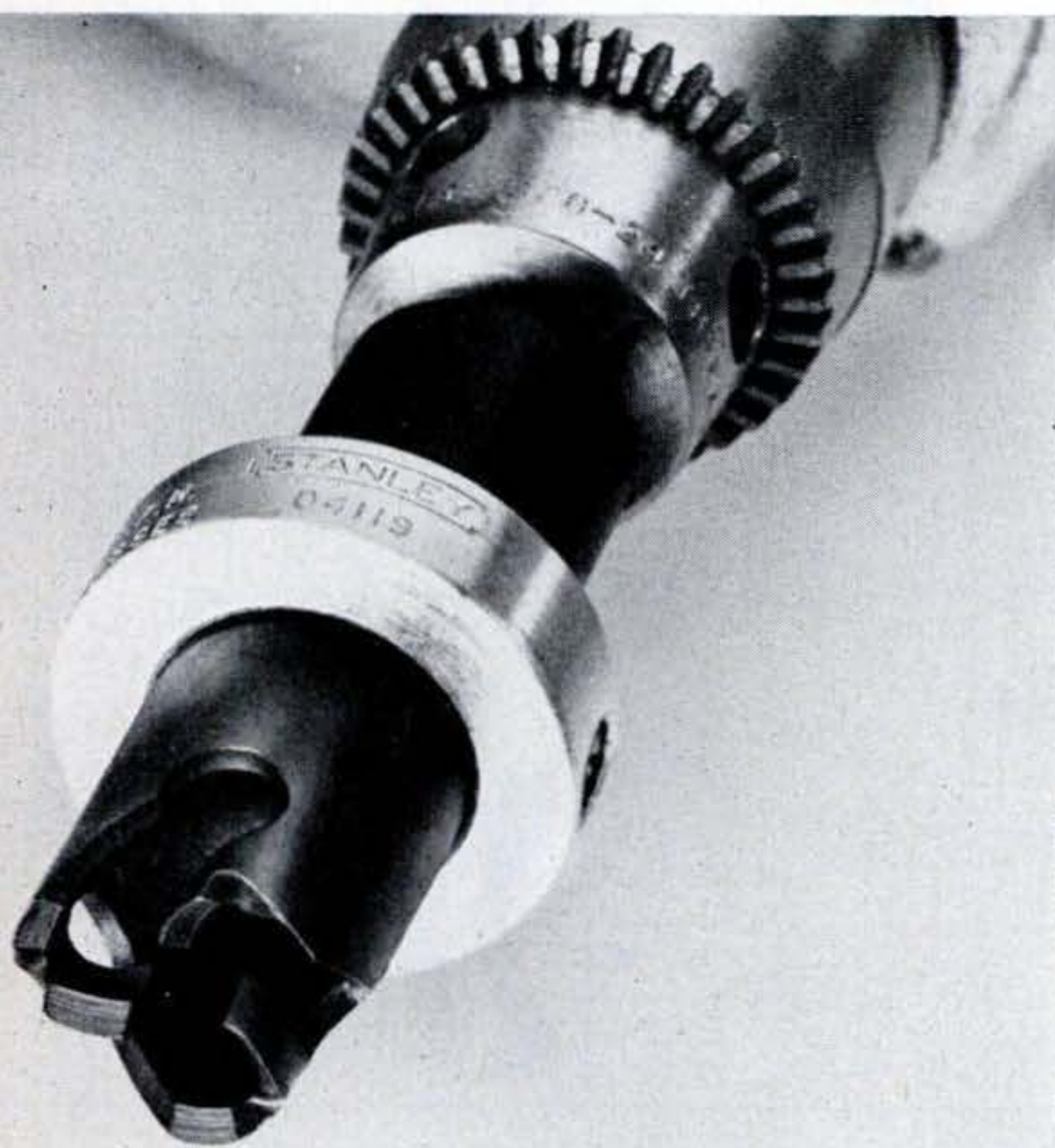


things to write for

- Just-published booklet: "Homeowner's Guide to Quality Roofing" (25¢ from SR&A, Box 3202, Grand Central Sta., N.Y., N.Y. 10017) helps you choose from many types of asphalt shingles now available; includes color guide, reroofing tips.
- Free folder that reproduces three recent Quaker State ads explaining how PVC valve works, how emission controls can up oil temperatures, how to protect engines from heat. Quaker State, Dept. EF, Box 989, Oil City, Pa. 16301.
- "Catalog of Handy Plans" including storage units, outdoor furniture, sturdy toys, with photo of each, and info on ordering working drawings. Send 25¢ to American Plywood Assn., 1119 A St., Tacoma, Wash. 98401; ask for Form X670.
- A thorough guide to buying plastics of all types is \$1.25 from Cadillac Plastic Mail Order Center, Box 03000, Detroit, Mich. 48203.



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Stanley's remarkable new Electrichisel™ tool works with any electric drill. Makes dado, rabbet and mortise cuts in wood.

As cut deepens, work drill to 90° angle with ring resting on guide to attain desired depth.

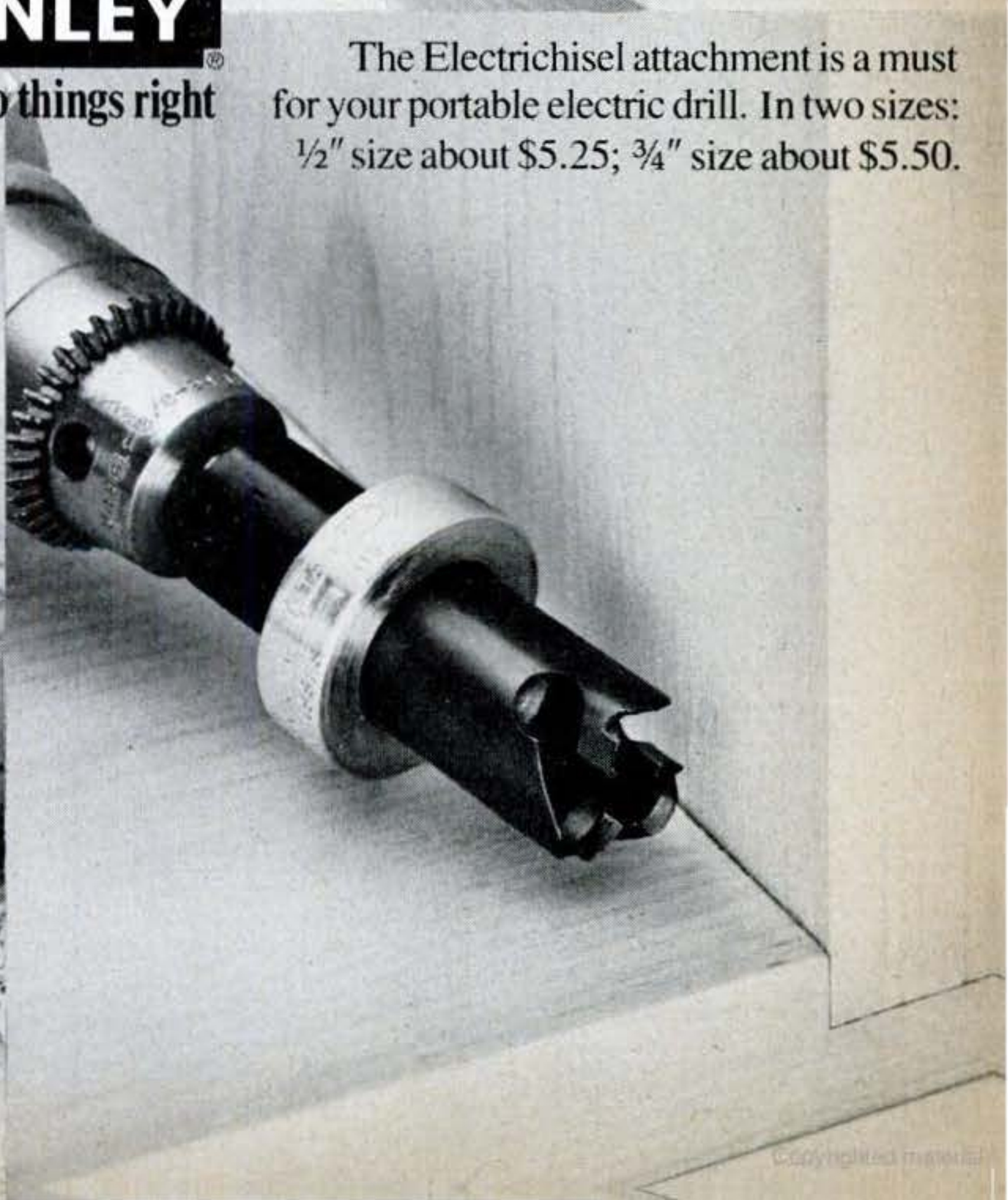


Just clamp a guide to the wood. Set depth ring. Start cut at 45° angle and work Electrichisel back and forth along guide.

STANLEY

helps you do things right

The Electrichisel attachment is a must for your portable electric drill. In two sizes: 1/2" size about \$5.25; 3/4" size about \$5.50.

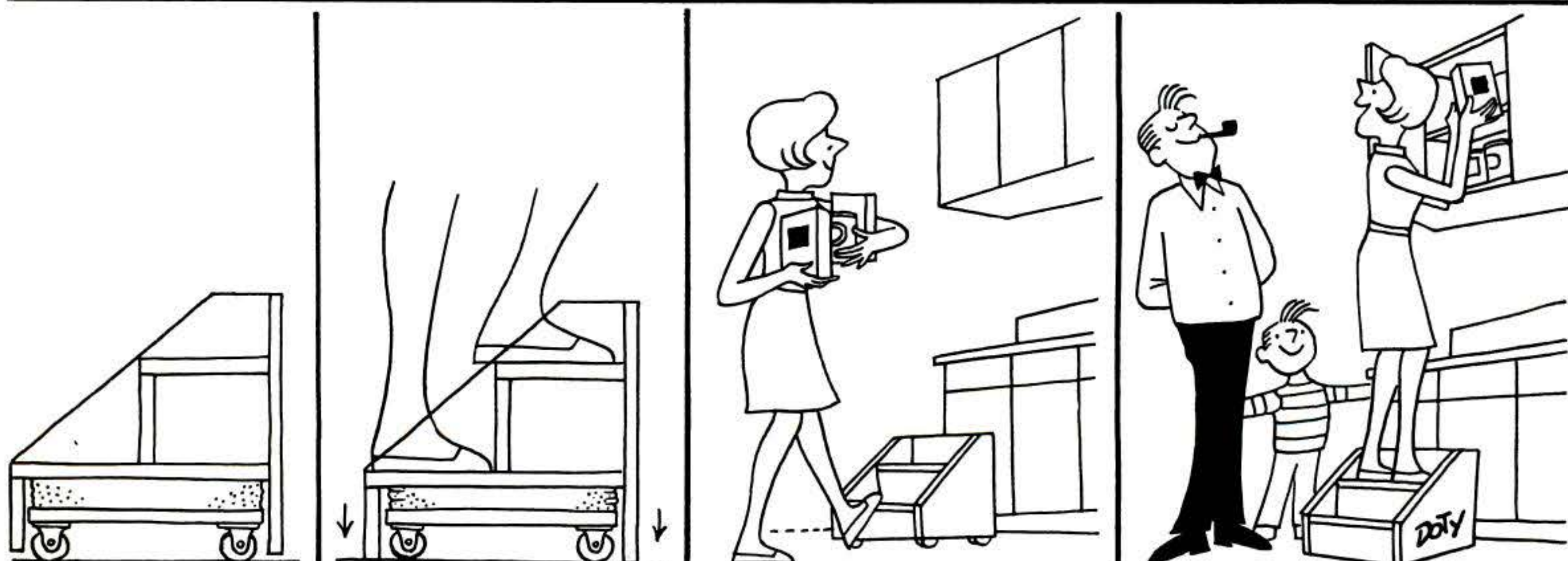
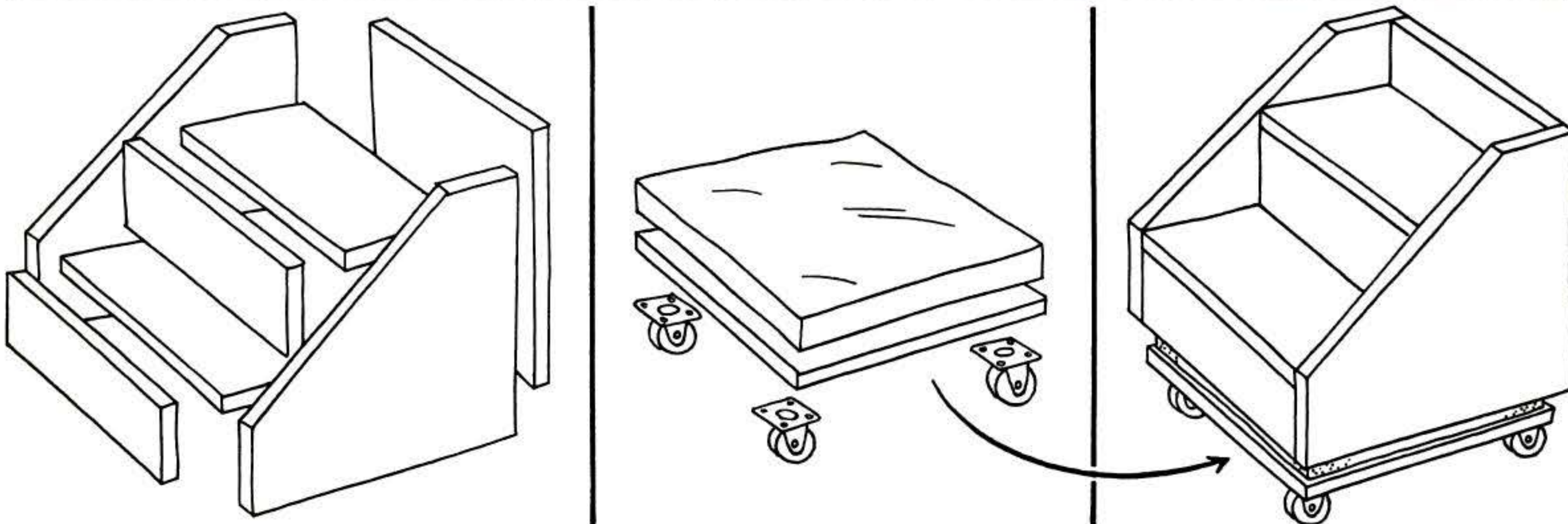
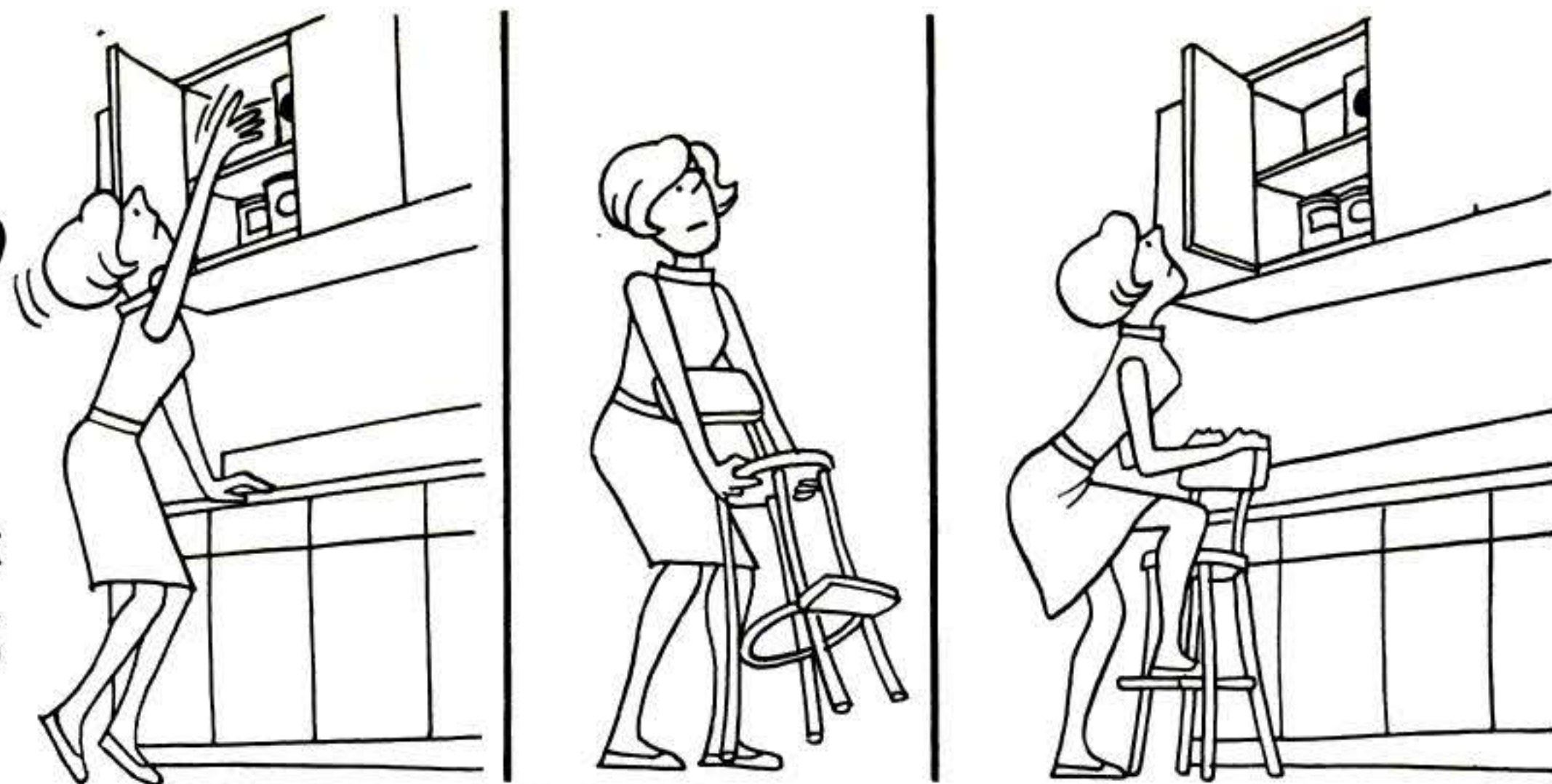


Wordless Workshop

By ROY DOTY

Idea by D. S. BURCH

\$25 to Mr. Burch of Ft. Worth, Tex. Send your idea to Wordless, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas can be acknowledged; none are returned.



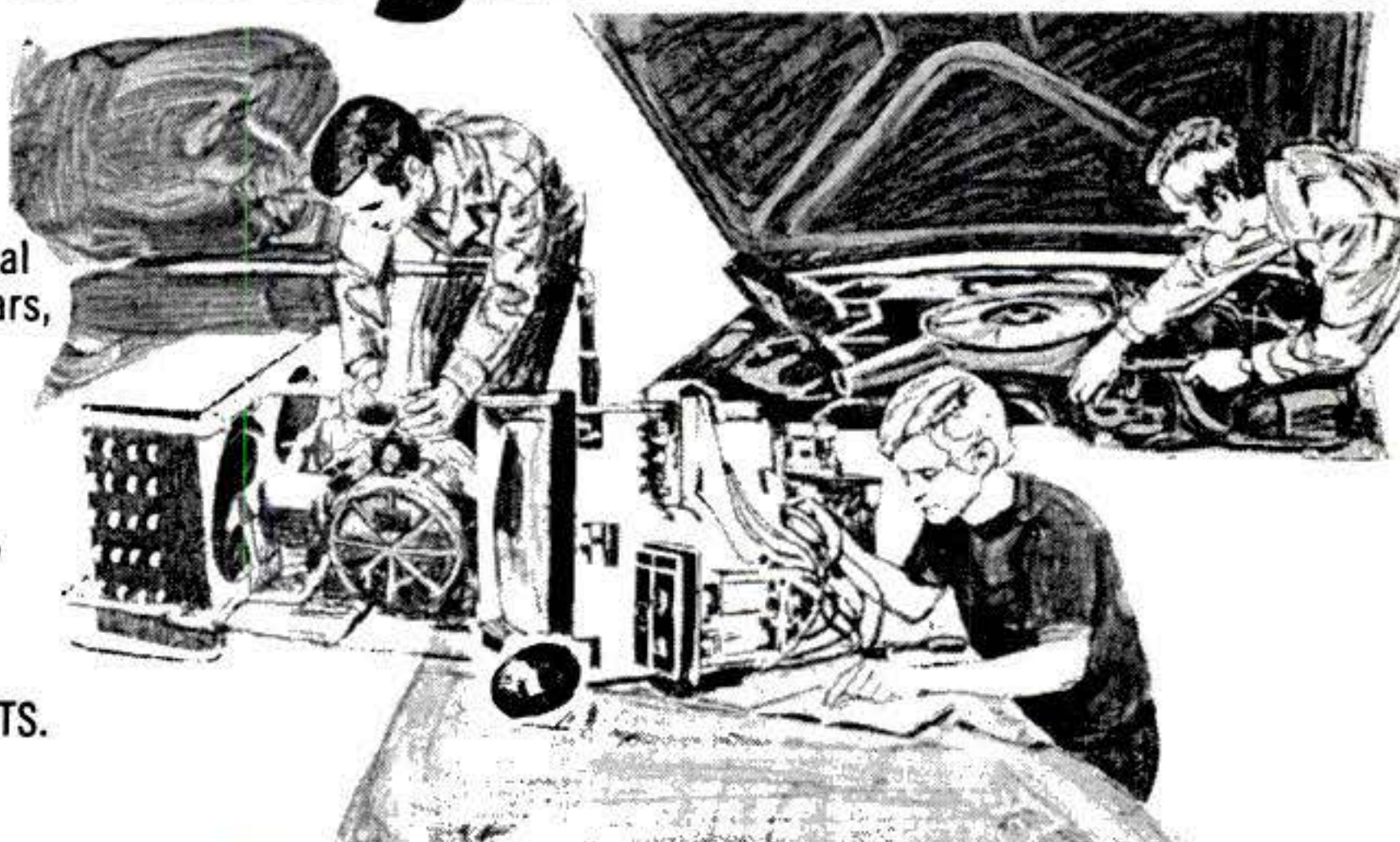
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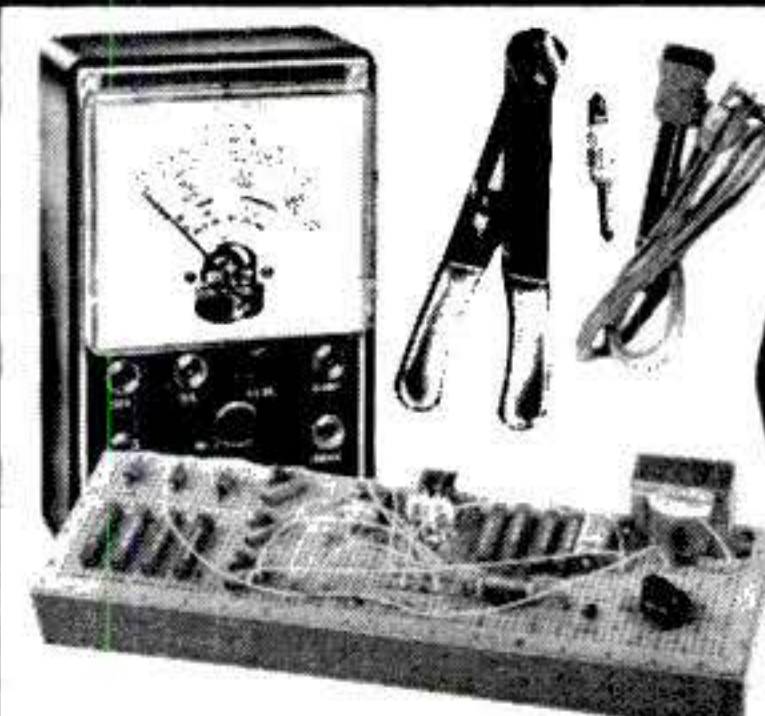
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Taking Care of Your Car

By RAY HILL

Good hints others have used

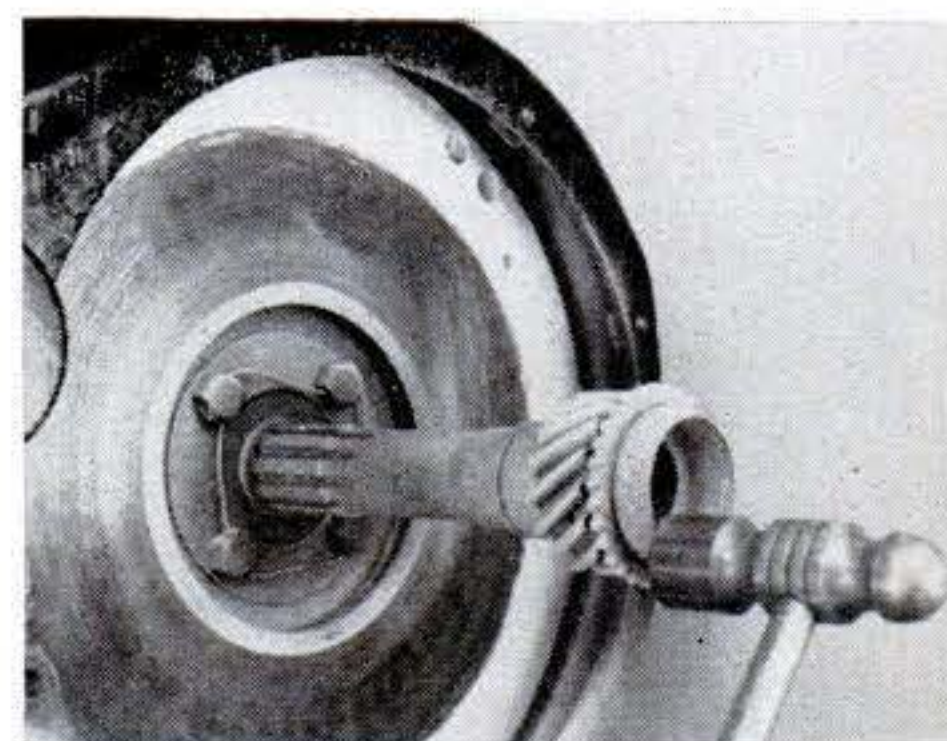
If you have a helpful car tip, send it to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll

pay you \$25 for each one we use. Photos aren't necessary. Sorry, but no tips can be returned.



Stiff rubber oil-filler cap

Age and exposure to engine temperature can make a rubber oil-filler cap hard and inflexible—making it difficult to replace after adding oil. A quick fix is to cut two V-shaped grooves in the cap's lower flange, as shown, with a pair of side cutters. This allows the rubber to flex so the cap can be easily slipped back into position.



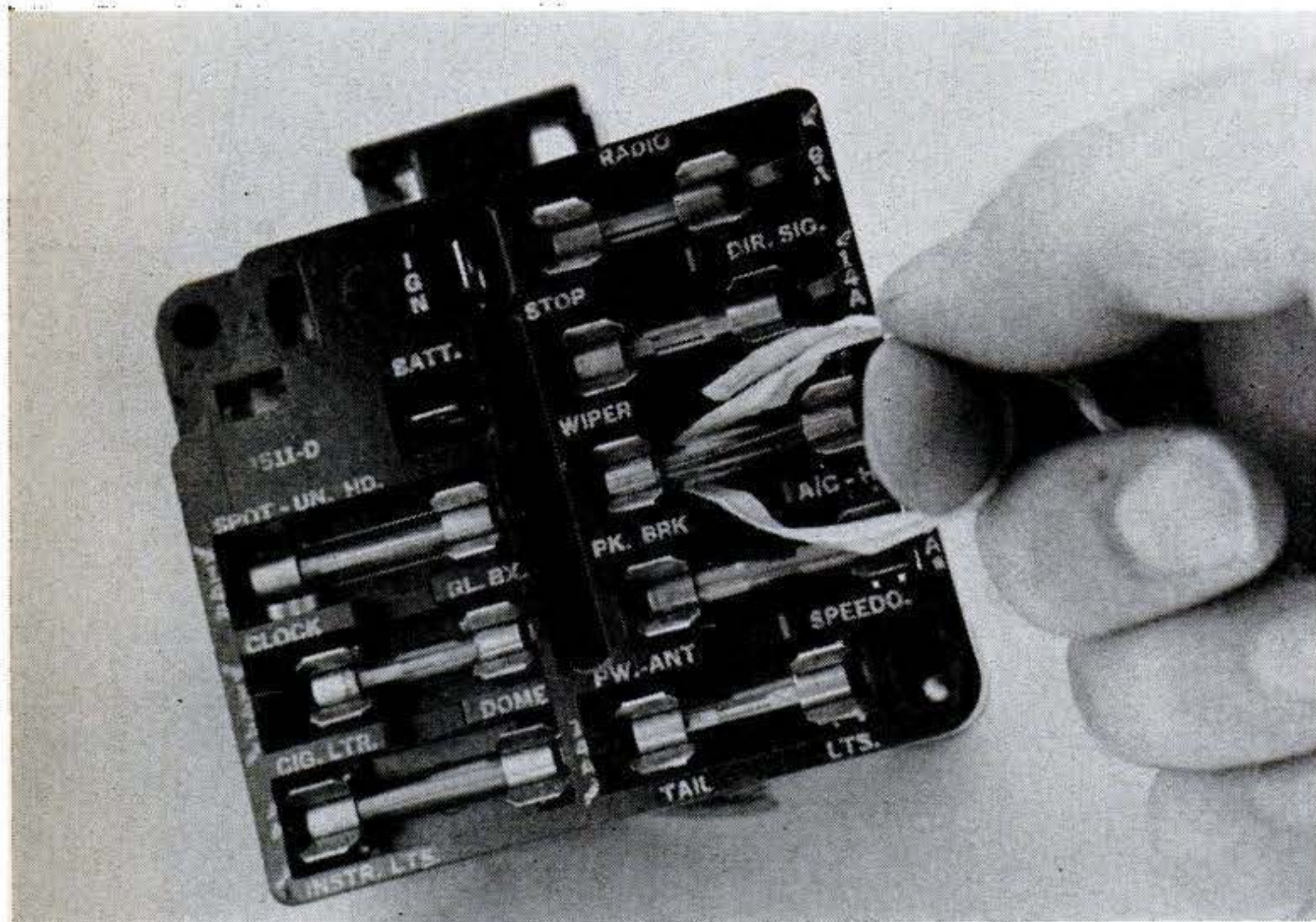
Pilot-bushing removal

If you don't have a puller, you may be able to remove a pilot bushing by using hydraulic force. Fill the area surrounding the bushing with heavy grease. Then take an old drive-pinion shaft like the one in your transmission and place it in the crankshaft as shown. Tapping the pinion shaft with a hammer should force out the bushing.



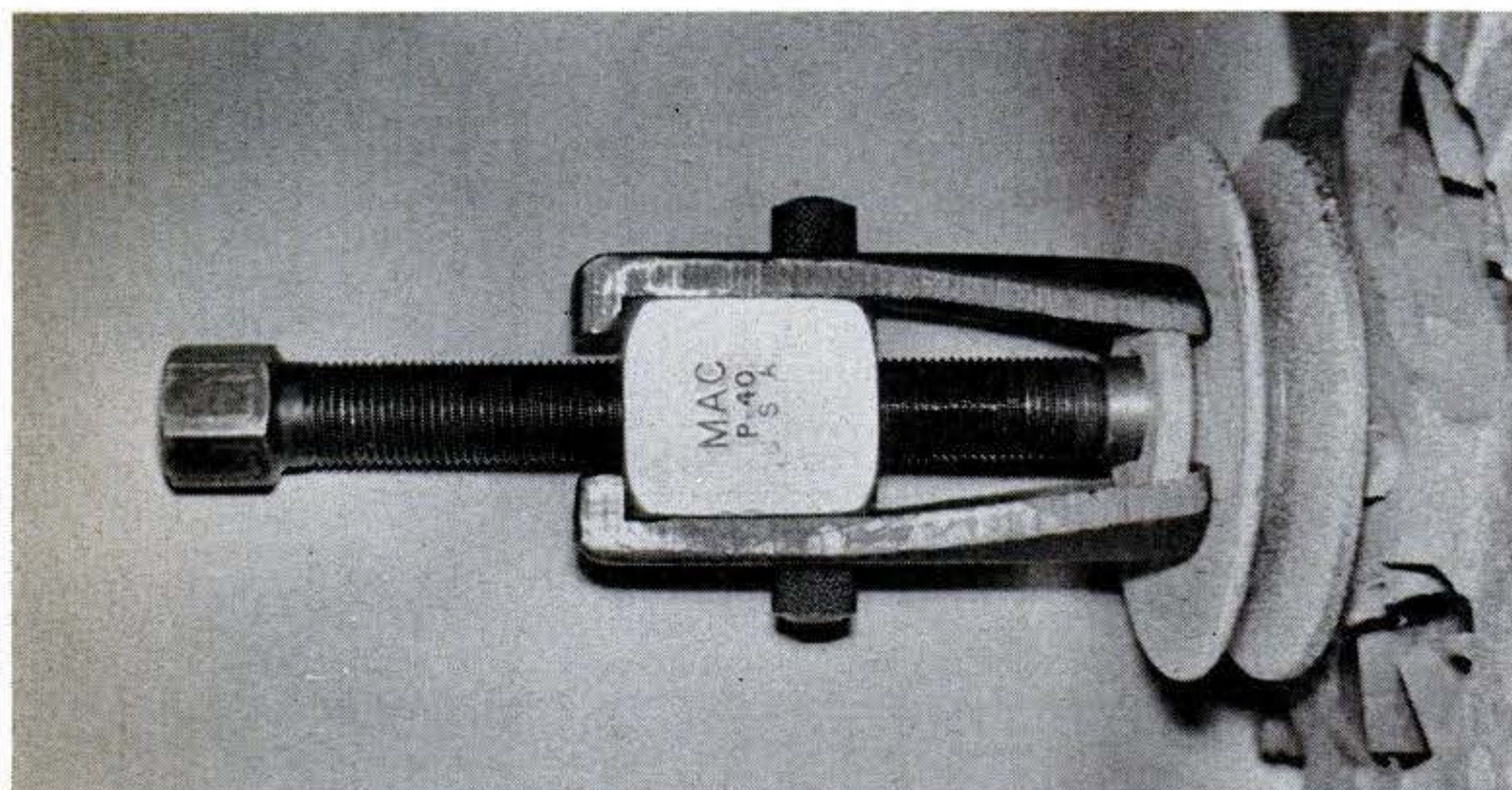
Replacing deluxe wheel covers

To prevent denting deluxe wheel covers, line up the hole in the wheel cover and the valve stem. Push the cover on the wheel and work it into the rim until all the teeth have entered except two or three on each side of the cover's half-moon cut. With a rubber mallet strike a perpendicular blow at the cut to seat cover satisfactorily.



Removing fuse from a hard-to-reach panel

Basically, fuses blow for three reasons: Current surge overloads the circuit; shorted circuit; or the fuse simply wears out. Because fuse panels are often located in barely accessible areas, removing a blown fuse can be difficult. One of the easiest ways to do the job is with one of the paper-covered twist-wires from freezer bags, garbage bags, etc. Slip the wire around the fuse and pull. If the replacement fuse blows, check the circuit for a short.



Proper removal of an alternator pulley

If you have to remove an alternator pulley, don't do it with a hammer and punch. You'll probably be able to get the pulley off the shaft that way, but there's a good chance that the rotor and pulley will be damaged in the process. The proper way to remove the pulley is with a puller. Even if you must buy or rent one, it's cheaper than buying a new rotor and pulley.

RICHARD PETTY says:

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"NRI provides the most up-to-date complete course in Auto Mechanics I've ever seen."

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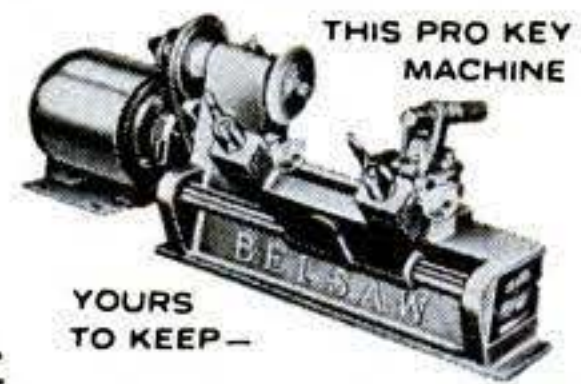
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Portable Wall Desk

[Continued from page 110]

the same splined-miter assembly. Before assembly—while panels can be handled flat—rout 1/8"-deep grooves for the brass trim. Note that the writing surface inside the drop leaf is faced with plastic laminate and framed with mitered edge strips. If you make those strips enough thicker than the panel to set flush with the Formica, you'll conceal and protect the laminate edges.

Abcite inserts. Size them for a snug fit. (I chose two thicknesses of Abcite, but this is optional.) For cutting, use a fine-tooth blade in a band, table, or jigsaw; for finger slots, I cut 1" holes on my drill press (1000-1500 rpm), completed them with two passes on my saw.

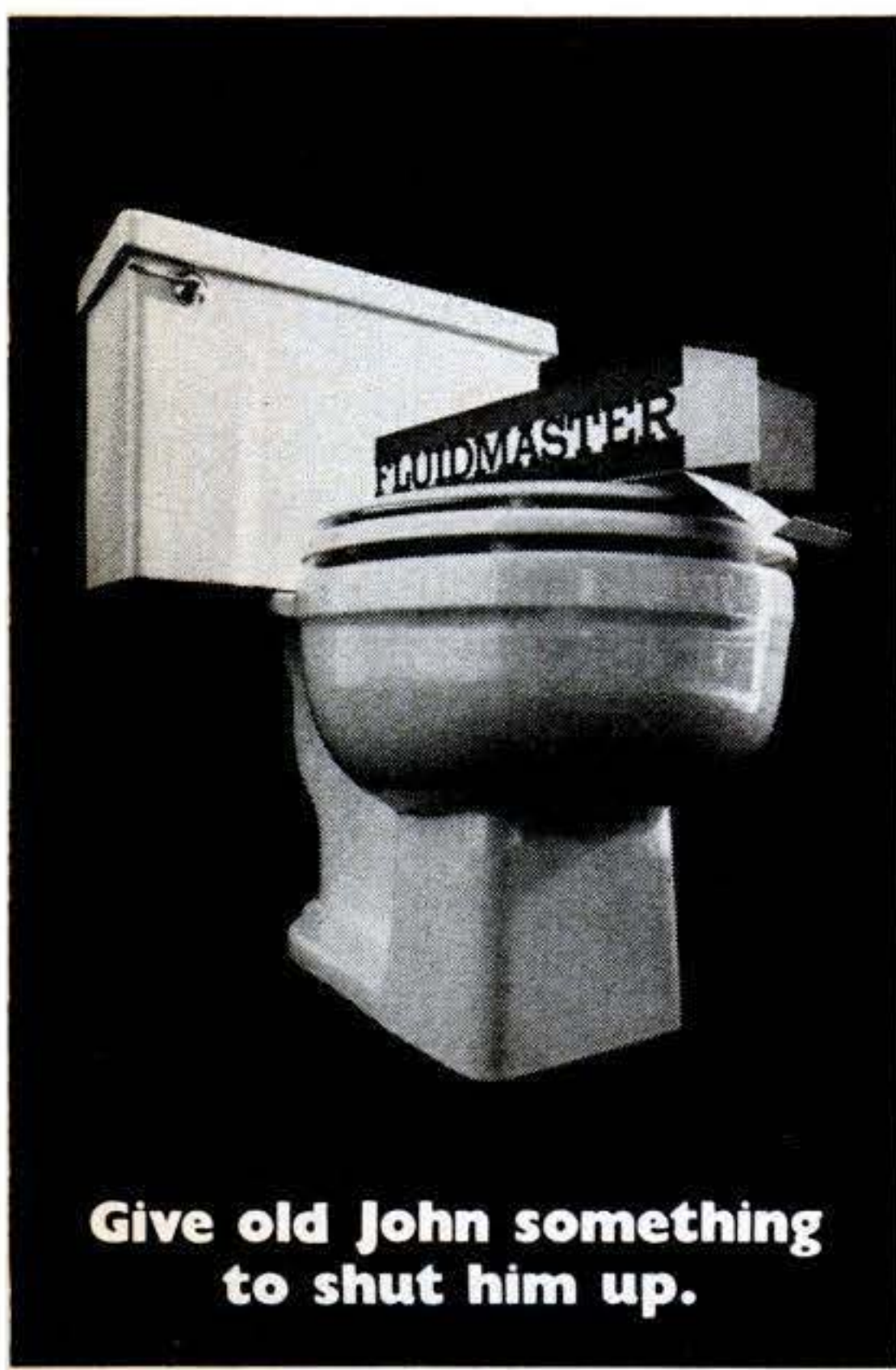
For square assembly, make the clamping jig shown. Cement fronts, bottoms, and one side of a unit at a time; clamp this in the jig for 24 hours, then slip the opposite side underneath after applying adhesive to all edges. To maintain contact, weight the unit (I used small cans of paint). Clean off excess adhesive with benzine or lighter fluid, wash with lukewarm water and detergent, polish dry with a soft cloth. Mount units inside the case with small brass screws through predrilled holes.

The hardware. Unable to locate hardware to support the drop leaf, I made my own. My cable is aluminum clothesline, but brass chain could be used; the upper supports are fashioned from brass angles bent in a vise. Each adjustable (and detachable) lower support consists of a short piece of slotted shelf standard plus one of the clip-in brackets sold with it. To close the lid, you can snap the clips from their slots to cross the cables inside.

The finish. It's especially important on a unit that is to be carried from place to place. I chose ZAR Satin Crystolite varnish, made by United Gilsonite. If your paint store doesn't carry it, use another good brand of polyurethane varnish.

Screw the modified-angle hangers on the back exactly 16" apart. Then, into every wall where the desk is to be positioned, drive a pair of heavy-duty picture hooks (the type that include an angled nail) aiming for the 16"-o.c. studs. Position these hooks so the bottom of the case will be just 30" from the floor.

I cut the cord of my high-intensity lamp near the base and attached a small female plug, which I mounted through the bottom of the case as shown. (You'll find them at any good electrical supply.) The extension cord stores in the desk.



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Maglev

[Continued from page 97]

times that beat flying. Lufthansa, Germany's national airline, looks forward to shedding some of its short-hop, low-return internal flights as a high-speed 480-mile maglev route linking Hamburg and Munich becomes operational around 1985.

What about wheeled railcars? Why not increase their speed? Even with special tracks, which cannot be used to transport heavy freight, speeds with conventional trains may be limited to under 150 mph. Despite nightly maintenance, JNR's present high-speed Tokyo-to-Osaka run had to be reduced from 150 mph to 125 mph. Tracks must be carefully aligned to minimize vibration as steel wheels contact the rails.

Intercity race. JNR believes its countdown to a high-speed maglev line will enable the line to meet greatly increased traffic demands in the 1980s. Although a race for the first major city-to-city maglev line is brewing between Japan and Germany, the Germans clearly lead the world in maglev hardware. Their government is shoveling in the cash to make sure it stays there.

Maglev trains being developed use various techniques to achieve lift, propulsion, and lateral guidance. One basic difference among maglev vehicles is whether magnetic attraction or repulsion suspends the vehicle. Two German firms, Krauss-Maffei (KM) and Messerschmitt-Bölkow-Blohm (MBB), as well as Rohr in the U.S., employ attraction.

Electromagnets on both sides of their test cars are attracted to the underside of steel rails, lifting the vehicles. This system is inherently unstable since the magnets want to clap against the rails as they approach them. The closer they get, the harder the pull. Sensors must constantly measure the distance between magnets and rails, regulating electromagnet voltages to maintain a half-inch air gap.

Levitation by repulsion. In contrast, Siemens in Germany and the Japanese are betting on repulsive levitation. This suspension technique requires powerful superconducting magnets mounted in the vehicle. On the guideway beneath the magnets are large, firmly anchored coils or continuous aluminum plates. As the vehicle passes over the guideway, the magnet coils induce current in the coils or plates. The current produces a magnetic field that opposes the field from the vehicle. Maglev cars are then repelled from the guideway, suspended from four

Continued

For my money and your car this is the hottest thing SINCE ROME BURNED

PERIOD! . . . Helluva Ignition Tom McCahill

When Tom McCahill tested Gaylord's CompuSpark™ Capacitive Discharge Ignition, he said flat out: "For my money, CompuSpark's a steal. Under 50 bucks. No moving parts. Fully electronic. Solid-state. And CD, too. It's built like a brick out-house. They tried to wear one out and stopped at 270,000 miles when the car fell apart."

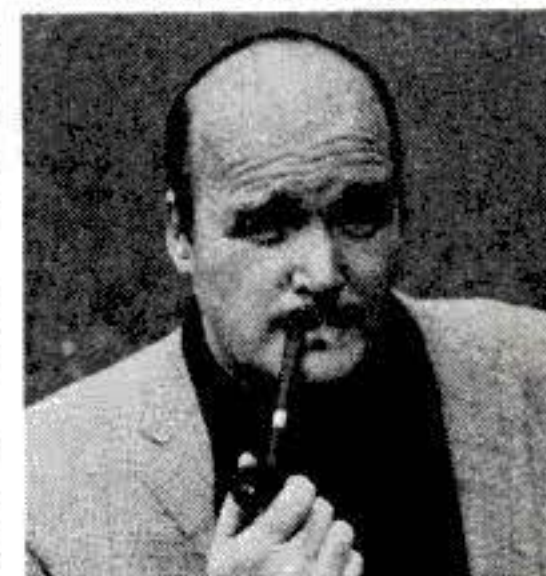
"What's in it for you? It virtually does away with point wear. Ends plug fouling hassles and puts plug wear way down the road. Often cuts your gas consumption by 20% and makes your engine run clean."

"The reasons for all this are as obvious as warts on a snake. An ultra high intensity spark is a helluva lot hotter than a stock ignition. CompuSpark—The Ignition System with a Brain™—actually computes spark characteristics to engine RPM. You get the right spark at the right time and the right place. Darned things run great in Alaska or the tropics. Why not? All silicon, y'know. And the anti-theft feature really works!"

"Another thing: CompuSpark is guaranteed one month longer than a Rolls-Royce: 37 months free repair or replacement. 60 day money-back guarantee, too!"

"Think of it this way: One skipped tune-up and CompuSpark has paid for itself. Two and you're money ahead. Three—no sweat with CompuSpark—and you're in clover, right? You bet."

"Order your CompuSpark now, it turned me on. I'm sure it'll turn you on, too!"



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Maglev: How They're Getting Trains Off the Ground

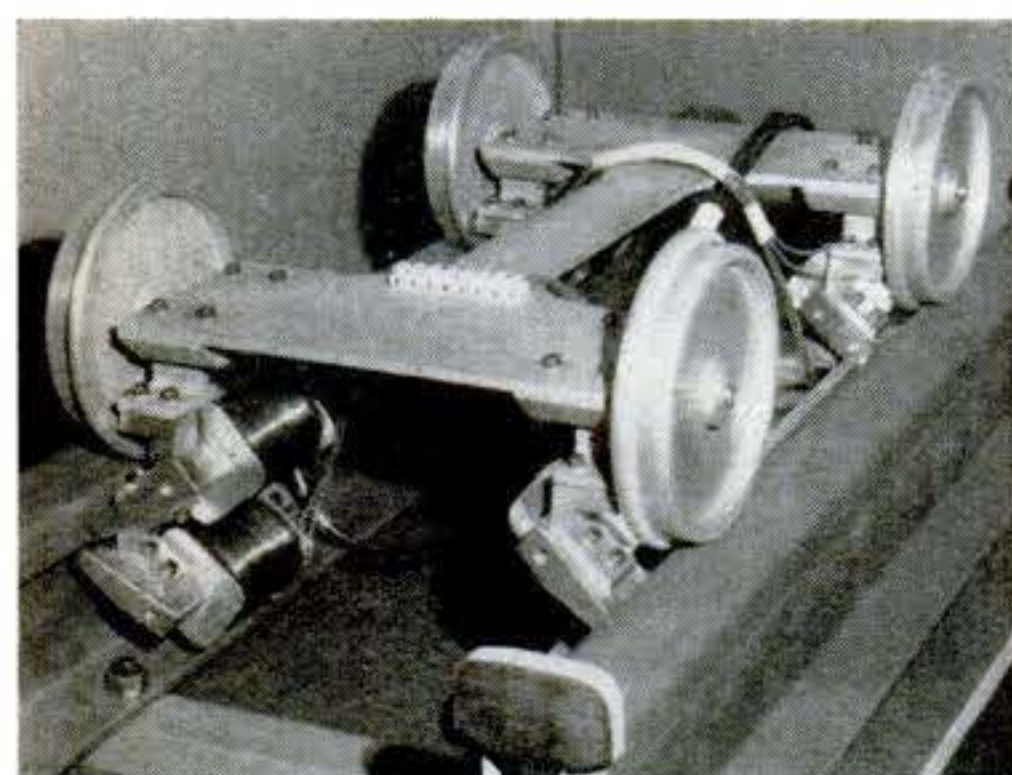
[Continued]

inches—as during recent JNR tests—to almost a foot, as some designs anticipate. Since the repulsive force becomes greater as the vehicle nears the guideway, this approach is inherently stable. No sensors are needed to regulate spacing.

Key advantages to superconducting electromagnets: They require little weight or volume to generate incredibly strong magnetic fields, and do not require continuous external power. When coils made with special alloys are cooled to about -450 degrees F, their resistance to current virtually vanishes. The 12-gauge copper wire used for your electrical outlets can carry some 20 amperes before overheating. But a superconducting wire of identical size can carry 10,000 amperes.

JNR's technique of operating superconducting magnets in the "persistent mode" during their tests will undoubtedly be applied to future passenger trains. Current needed to generate the repulsion fields is applied to the coils at terminals, and the power is disconnected. The coils are then shorted. Since the current encounters no resistance, the fields persist for extended periods.

Scaling maglev up. Both attractive and repulsive levitation systems have problems unique to them. In London, Prof. Eric Laithwaite, widely known as "the father of the linear motor," has strong opinions of various maglev techniques. "I know the Rules of God," he says whimsically, "and MBB and KM [attractive maglev] are fighting them."



Maglev conversion system would enable conventional trains to run at 180 mph on existing rails, according to Maschinenbau Augsburg Nuernberg. Each wheel would be floated a half-inch above rails by a levitation magnet beneath it. Using attraction, magnets would pull upward against the underside of the steel rails. Similar guidance magnets facing the rails would keep the axle centered. For propulsion, linear-induction motors would react against the upper surface of the rails. Cars would roll on their wheels only for low-speed running and shunting, when magnets would be shut off.

These "rules" are the natural limits to which anything can be scaled up or down and still function as intended. Attractive levitation won't scale up as expected, he argues. It's one thing to run a 10-ton car at 100 mph with a half-inch air gap, but a very different matter to propel an 80-tonner at 300 mph with the same clearance. With a small air gap between magnets and rails, a dead-accurate track is expected to be absolutely essential.

But the high cost of building and maintaining such a track for hundreds of miles would make larger air gaps mandatory. Merely doubling the gap would require lift magnets with 16 times the power. And because of added weight, you'd have an ostrich-like vehicle unable to "fly" with an economic payload.

Laithwaite is kinder to repulsive levitation, for repulsion is "on God's side." This system "gets better as it gets bigger," he says. Lift is not related to constant energy consumption, and the large suspension gap means noncritical track tolerances.

What are the snags? Repulsive levitation requires wheels or another means of suspension for slow-speed running. This is because the current strength and repulsion field induced in the coils or continuous metal plates provide lift only when magnets reach 20 mph. Superconducting magnetic fields will penetrate an aluminum sheet until at about 20 mph the eddy-current magnetic field repels it.

Another problem is the magnetic "drag" inherent in repulsive levitation. The drag is unavoidable, since the current induced in a track loop or aluminum sheet begins to decay during passage of the vehicle magnet. As the vehicle begins to pick up speed, magnetic drag climbs steadily; at about 20 mph it begins to fall off.

Maglev propulsion. Siemens' initial design plan for a repulsive-levitation vehicle (see drawing) calls for a double-sided linear induction motor (LIM) in the vehicle straddling a continuous vertical reaction rail along the guideway.

The on-board sandwich-type primary windings correspond to the fixed armature surrounding the spinning rotor in an ordinary motor. The magnetic field of the LIM windings induces currents and opposing fields in the fixed reaction rail (secondary), which corresponds to a rotor. The interaction of opposing fields spins the rotor in an ordinary motor, but thrusts an LIM primary

and attached maglev vehicle linearly along a reaction rail. Such on-board LIM primaries require an enormous electrical input through flexible collection arms that make contact with power rails paralleling the guideway.

The Japanese avoid the problems of power collection—and reduce vehicle weight considerably—by installing primary coils on the guideway. With this technique, the LIM secondary is a reaction plate hung from the underside of the vehicle. When the plate passes between the fixed primaries, spaced every 25 feet along the guideway, the vehicle is thrust forward. Such an approach, one type of active guideway, simplifies propulsion, but track costs rise.

New flat motors. Laithwaite now feels that double-sided LIMs are "far too dangerous." Thermal expansion and the risk of traveling mechanical ripples on a reaction plate could be disastrous at almost any speed. The Germans are switching to flat, single-sided LIMs or other propulsion techniques for newer vehicles. In his Imperial College lab, Laithwaite has developed a "transverse-flux" linear motor that provides both magnetic lift and propulsion.

Another active-guideway propulsion technique undergoing tests in Japan is the linear synchronous motor (LSM). It's a likely candidate for the Tokyo-to-Osaka maglev route. Last year JNR tested a 13-foot research sled (not illustrated) designed to check various propulsion methods. The sled carries two superconducting coils with different polarities that levitate it above a string of doughnut-shaped coils in the center of the guideway.

These on-board magnets also play a role in propelling the sled by interacting with thrust loops strung along the guideway. Voltage applied to these loops generates a traveling magnetic field synchronized with the on-board magnetic fields. The interaction of the fields constitutes an LSM that propels the sled along the guideway.

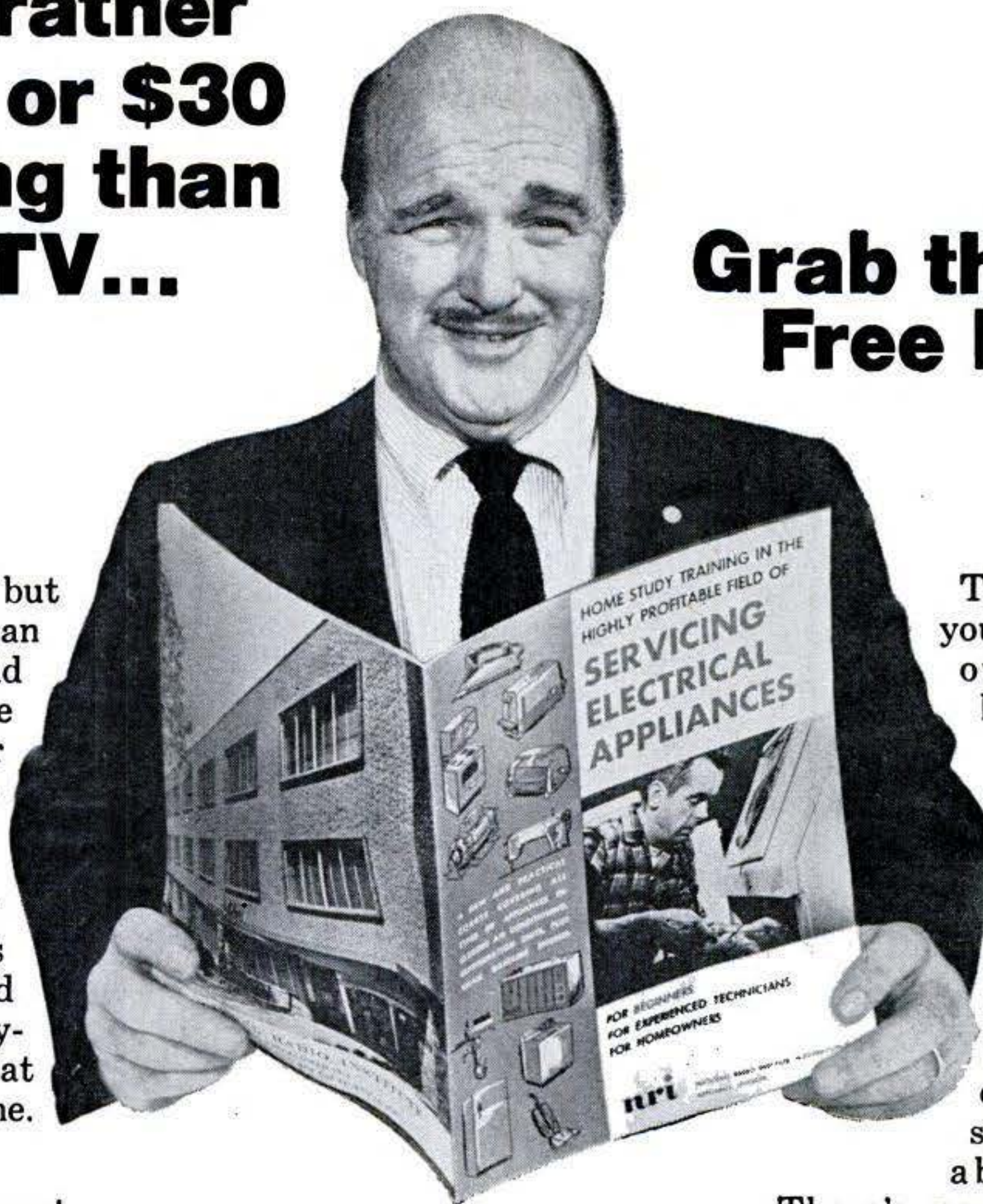
Magneplane vehicle. The Japanese LSM test sled is suspended and propelled somewhat like the M.I.T./industry Magneplane (see drawing). In the U.S., the Magneplane has advanced to a 1/25 scale model but at present there is no funding to expand it to a larger-scale system. As the pace of development quickens in Japan, Germany, and Canada, an operational maglev train route should become a reality sooner than we think. [25]

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Recips

[Continued from page 118]

• **Stanley.** This is the smallest saw, and also the smoothest running, thanks to a special counter-weight in the drive system. I'd pick the Stanley over the others for shop work where control and accuracy are important. It's the easiest to handle on plunge cuts, too. To me, the Stanley is an in-between saw, a compromise between a saber saw and an all-out reciprocating saw.

Using the recips. All the recips cut on the backstroke. This tends to pull them against the workpiece automatically on light cuts. But when you start to work a recip hard, its blade may bind. When this happens the saw moves, and the blade stands still. To prevent this uncontrolled shake, it's important to push the saw's soleplate firmly against the work.

Whenever possible I like to hold the work vertical so that sawdust falls out of the way. On horizontal work, sawdust buildup often obscures your cutting line.

Cutting curves. Controlled scroll cuts are not a top-priority recip design goal. Used like a saber saw, they're top-heavy and hard to guide accurately. To get the best curve cutting out of a recip, devise a wooden jig to hold the saw upside down with its blade sticking up through a small work table. This jigsaw setup lets you guide your work with two hands and puts the good side of the work up so that any chips are on the back face. Unfortunately, the saw most suited to this application—the Stanley—doesn't have a trigger lock.

Blades. Although some saw makers claim that blades are usually interchangeable from brand to brand, my experience doesn't support the claim. I had to do a little fudging with a grinder to get a Sawzall blade into the Rockwell saw. Fudging isn't a good idea if you can avoid it. These blades are designed to fit the blade clamp at a specific angle. Any tampering with the blade tang can throw the angle off. In addition, Milwaukee Electric Tool says its blades have teeth milled, set, and hardened to work best at Sawzall speeds.

All this means you're smart to buy a saw with a wide range of blade choices if you're interested in getting the most out of your saw.

The five saws tested here are just a few of those available. Millers Falls, Skil, and Black & Decker also make linear types. Skil, Shopmate, J. C. Penney, Wen, and Toastmaster offer offset recips. **PS**

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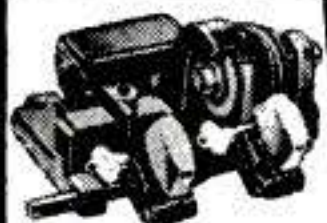
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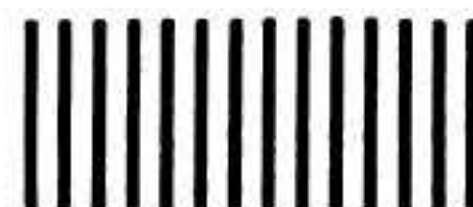
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Our First Close Look at Jupiter

[Continued from page 72]

often in roundabout ways, from simple data:

- These instruments' findings may help to explain the Great Red Spot; indicate whether Jupiter has a polar cap; and reveal the temperature of its dark side.

- Many astronomers see signs that Jupiter radiates two or three times as much energy as it receives from the sun—but this amazingly starlike behavior, for a planet, has never been proved. Pioneer's infrared radiometer should settle it.

- Jupiter's hidden surface may not be a solid one, but a storm-tossed ocean of liquid hydrogen (the main fuel of our Saturn moon rockets). Pioneer's thermal data, analyzed and related to other findings, will give a better idea of Jupiter's surface composition. It should also tell the exact ratio of Jupiter's two most-abundant elements, hydrogen and helium, which is considered a key clue to understanding the planet's strange makeup.

Weighing Jupiter. Without even using on-board instruments, Pioneer 10 will weigh Jupiter more accurately than ever before. Tracking data on Earth, computer-processed to reveal the planet's effect on the spacecraft's course, will pinpoint Jupiter's mass—and thus circumscribe more narrowly what its innards could possibly be made of. (The hydrogen-helium ratio, too, should tell something about the composition of its deep interior.)

Because Jupiter appears so much lighter in weight than would be expected from its size, its inside seems bound to be something extraordinary. Many believe it consists largely of metallic hydrogen, a substance that theoretically could be formed from ordinary hydrogen under Jupiter's presumed internal pressure of millions of atmospheres. (Recent U.S. and Soviet attempts have been made to produce metallic hydrogen on Earth, with high explosives, but proof of success is still awaited.)

A four-second burn of Pioneer 10's thrusters recently trimmed its course slightly to assure that it will pass behind Jupiter's orange moon, Io, about the size of our own moon. As it does so it will tell whether Io has an atmosphere, by the effect on Pioneer signals to Earth that would pass through it. The same technique will explore the ionosphere of the Jupiter atmosphere.

Like the Earth, Jupiter has a magnetic field—and a magnetometer on a long mast extending from Pioneer 10 will measure its strength.

Also like the Earth, Jupiter has Van Allen belts of radiation—but believed many times as powerful. They are held responsible for much of the radio noise emitted by Jupiter—which, to radio astronomers, is the noisiest of the planets. Pioneer 10 will sail right through the belts, gathering information about them with a whole array of instruments—principally, a Geiger-tube telescope and a “trapped-radiation telescope.”

Will radiation thwart mission? Observers on Earth will have tense moments as Pioneer 10 braves Jupiter's Van Allen belts. Depending on the radiation's unknown intensity, it might imperil the mission by knocking out some if not all of the Pioneer instruments. Designers have taken the threat seriously enough to provide for disconnecting damaged elements from a multiple-sensor instrument, by remote command.

But even if worst came to worst, Pioneer 10 has a backup. Trailing along behind it is a twin—Pioneer 11—built by the same maker and carrying the same instruments. (It also has a magnetometer to measure a more intense magnetic field than Pioneer 10 could, in case Jupiter's is stronger than anticipated.) It was launched last April and will reach Jupiter in 1974. When we know Pioneer 10's fate, there'll still be ample time to alter the course of Pioneer 11 accordingly.

If Van Allen radiation has blitzed Pioneer 10, Pioneer 11 may be taken through a higher, less-damaging trajectory—at the cost of some resolution in pictures and sensor readings.

But if Pioneer 10 comes through with flying colors, Pioneer 11's controllers probably will be emboldened to send it swooping down to a “grazing” flyby only 21,600 miles from Jupiter—and to pictures of greatly enhanced resolution.

As I write this, Pioneer 10 has already scored a space triumph—the first exploration of the Asteroid Belt, which it took seven months to cross. By emerging unscathed, it allayed fears of the threat of this celestial obstacle course—made up of flying chunks of cosmic debris of up to 488-mile diameter—to spacecraft bound for the outer planets.

All we really knew before about the Asteroid Belt was that it included 1776 identified objects of more than the minimum size our most powerful telescopes could detect—about a mile in diameter. These were considered too few and far between to be likely to imperil a spacecraft; the worry was whether the belt might

be filled with zillions of smaller particles, down to the size of a grain of sand, that could still damage a craft or its delicate equipment. Now we know that it isn't, and that Pioneer 10's successful crossing wasn't just a lucky chance.

Asteroid Belt no menace. We have the inside story from two devices, included for the purpose, in Pioneer's instrument package. A set of hollow, gas-pressurized panels registered punctures by the smallest particles, and an array of optical telescopes observed particles up to a diameter of about one mm (or 1/25 inch) passing near the spacecraft. (Larger ones, relatively rare, were of less concern.)

What Pioneer 10 reported will rewrite the textbooks. Particles of 1/10 to one mm were only three times as plentiful in the Asteroid Belt as outside it. Smaller particles, contrary to expectations, were *no more* numerous there than elsewhere. Exit that bugaboo!

En route, Pioneer 10 has been making good use of other instruments. One called a plasma analyzer, observing ions and electrons from the sun, is studying this “solar wind” to ranges unexplored before. A cosmic-ray telescope has been reporting data new to science. The Jupiter camera has had an advance workout, mapping “zodiacal light” scattered by interplanetary dust.

Beyond Jupiter. As Pioneer 10 loops around the far side of Jupiter, the mighty gravity of the orbiting planet will accelerate it as if it had fired another rocket stage, to a new speed record of more than 80,000 mph. This “gravity assist” will send it hurtling across the orbits of Saturn, Uranus, Neptune, and Pluto (without, however, coming near any of them)—and clear out of the solar system. On the remote chance that it might ever be sighted and recovered by other-worlders, it bears a gold-anodized aluminum plaque with symbols and pictures to tell them whence it came.

Pioneer 11 may elaborate upon the script for its predecessor. If it does descend to within 21,600 miles of Jupiter, its sharper zip-around course will put it in a trajectory to intercept Saturn in 1980—with its observing gear and radio still in business. Thus, seven years after you read this, a long-forgotten Pioneer 11 might surprise the world with a bonanza of data and pictures of the next big puzzle “out there,” the planet Saturn with its unique rings and many moons.

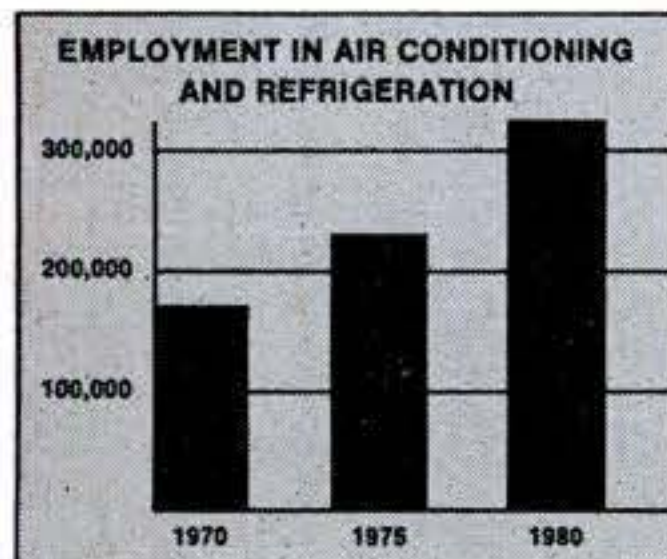
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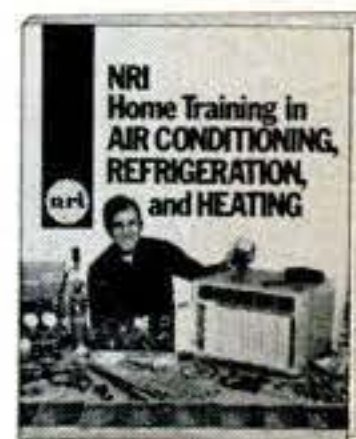
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Earthquakes—Now Science Can Predict When and Where They'll Happen

[Continued from page 81]

was something like this: As stress in a fault zone builds, the rocks reach the point where they are about to fail. At this point, dilatancy sets in and a network of small cracks radiates throughout the stress zone. This brings about dilatancy hardening—another laboratory-discovered phenomenon—which actually keeps the earthquake from happening temporarily.

Since a lot of cracks have opened up, the normal water contained in the immediate area is not sufficient to keep the rocks saturated. Thus they abruptly switch from a saturated state to an unsaturated state. And, as predicted by Brace's curves that show that P-wave velocity is lower in dry rock than in saturated rock, the velocity ratio drops abruptly. Gradually, water from the surrounding area seeps into the dilatant region. As it fills more of the cracks, the velocity ratio gradually climbs back to its normal value near 1.75. When the cracks are full once more, the dilatancy hardening effect is canceled, the rocks fail, and the earthquake happens.

Nur published his results first, thus is officially credited as being the first to reveal the overall plan. But before the studies were even published, another exciting research project got underway at Cal Tech. Drs. James Whitcomb, Jan Garmann, and Don Anderson, who had heard of the dilatancy model, began examining old seismic records leading up to the killer San Fernando earthquake of February 9, 1971. And they discovered the same phenomenon: Velocity ratios had dropped sharply before the quake, then gradually climbed back to normal, arriving there just before the event.

The news was electrifying. Not only was there now some theoretical insight into what was happening and why, but it had been detected in three highly different areas—the Garm region of central Asia, the Adirondacks of New York State, and Southern California. In addition, the new tool seemed to promise not only to indicate *when* an earthquake was coming, but *how large* it would be. The bigger the mass of rock under stress, the larger would be the eventual break and the more energy released in the earthquake. Also, the larger the mass of stressed rock, the longer it would take for water to trickle back in and fill the cracks. Thus the bigger the coming quake, the longer the velocity anomaly would last—that is, the longer it would take for the velocity ratio to drop

below the norm of 1.75, then return.

The experimental evidence bore out the calculations dramatically. Small quakes (about magnitude 3) at Blue Mountain Lake had velocity anomalies lasting only three or four days. The duration of the velocity anomaly of the magnitude 6.4 San Fernando quake was three and a half years. And, it was calculated, a really monster quake such as the 1964 magnitude 8.4 Alaska event would give its warning *40 years ahead of time!*

The dilatancy theory explained a lot of those other precursors that had been observed, too. Electrical resistivity, for example, would drop during the dilatant period as the rock dried out, then return to normal. As the rock fractured during dilatancy, more ground water would flow through the cracks and the radon content would increase, just as the Russians had observed. The ground tilt and uplift that had been measured so often before quakes, especially in Japan, was an obvious result of the dilatancy as the underground rocks expanded and literally lifted the surface of the earth above them. And the strange behavior of small earthquakes leading up to a major quake could now be explained, too.

It had been observed that the number of microshocks increased some time before an earthquake, decreased, then increased again. Now it could be seen that they first increased as stress began to build, decreased as dilatancy hardening tended to lock the fault, increased again as failure leading to the main quake began.

Better than gambling odds. But the really exciting thing about the dilatancy theory as a predictor is that it is *deterministic* rather than *statistical*. Once dilatancy begins, an earthquake is inevitable. The changing velocity ratios should be an absolutely accurate predictor—no false alarms.

Finally, it ties up the business of earthquake control into a neat package as well. Over the last several years, geologists Barry Raleigh and John Healy of the NCER have been conducting a fascinating experiment at an oil field in Rangeley, Colo. ["Can We Stop Earthquakes from Happening?" PS, Apr. '69.]

To harvest as much oil as possible, the operators of the Rangeley field used a common technique called flooding. They pump in large quantities of water at high pressure around the field's periphery. This forces the remaining oil toward the

center, where it is removed through wells.

But a surprising thing happened as the flooding progressed. A series of minor earthquakes hit the region. Raleigh and Healy undertook an experiment and in 1971, with the cooperation of the oil company, began a separate pumping operation in the direct vicinity of the fault that runs through the field. Since then, the researchers have pumped water out of the ground, lowering the pressure. This abruptly shut off the earthquakes that had been occurring. They pumped water in again, and again the quakes started. Now, they're going through the whole cycle again, and over the next couple of years hope to prove that it wasn't coincidence. But it fits the picture.

Earthquake control. Raleigh and Healy are apparently able to turn the quakes on and off by withdrawing fluid from the cracks (thus inducing dilatancy hardening) or re-injecting it (thus triggering the quake). Although it will be many years before anyone is ready to attempt such an experiment, it may be possible eventually to control quakes along the earth's dangerous faults—the San Andreas near San Francisco or Los Angeles, for example. Raleigh thinks it might be feasible to pump in water to small segments of the fault to trigger small, harmless quakes. Simultaneously, water would be withdrawn from areas on either side to lock the fault there and confine the extent of the quake.

But problems remain. The new theoretical insight doesn't mean the end of man's problems with earthquakes. In fact there are still a number of problems. A major one is that all of the experiments so far have taken place on thrust faults. Nobody knows whether the same mechanism is at work on strike-slip faults or not. At a recent conference of seismologists, I heard a number of papers given by scientists who had attempted to find dilatant effects preceding strike-slip earthquakes. Some seemed to find them, others did not.

Even if the technique works only on thrust faults, it will be of enormous value. Most of Japan's earthquakes are on thrust faults, for example. And the San Andreas and its associated fault systems in California contain a combination—some thrust, some strike-slip.

Another problem is that the quake doesn't happen instantly as soon as the velocity ratio returns to normal;

Continued

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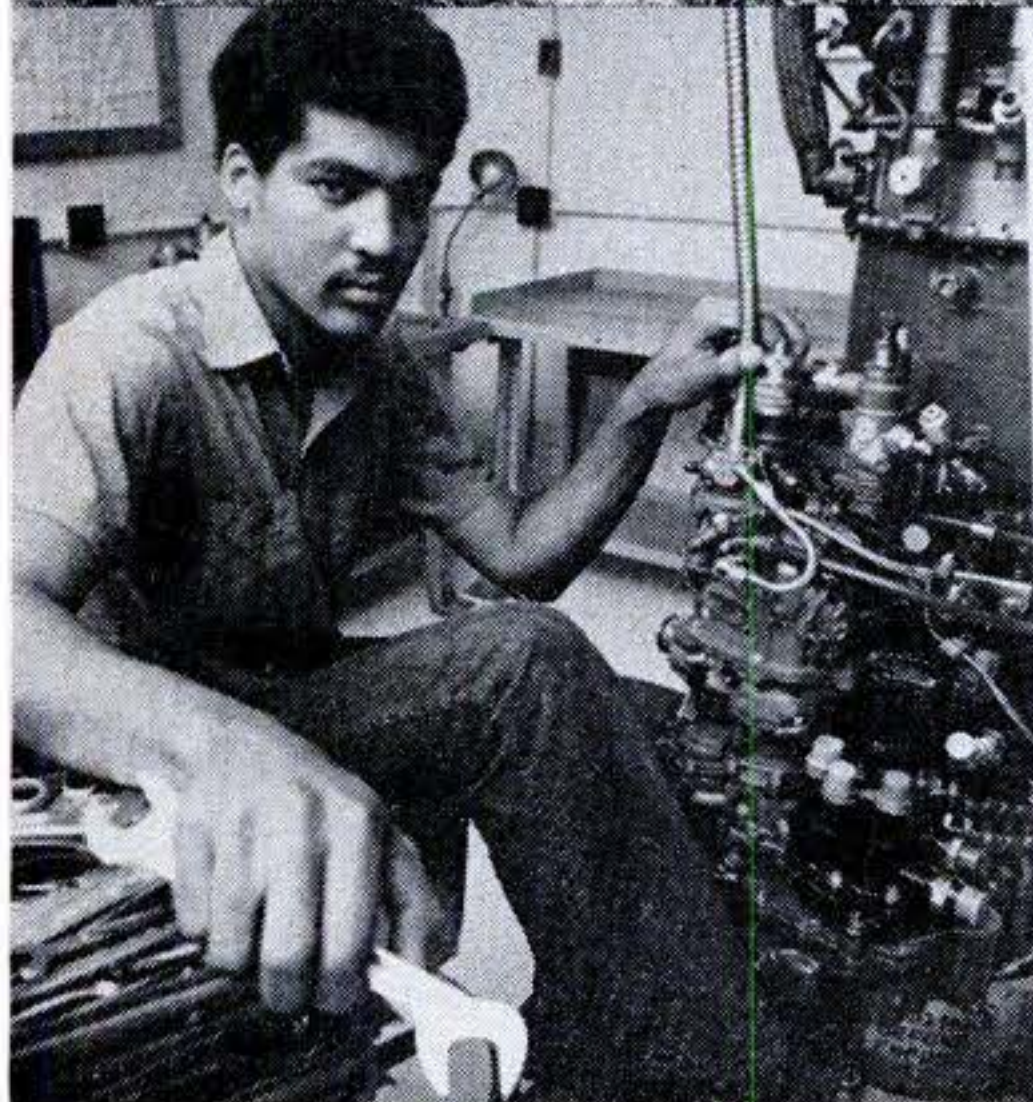
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Earthquakes

[Continued]

it happens a short time after. But for a major quake with a dilatant period of 20 to 40 years, for example, the target date might be only within a few years. Researchers are now hoping to use not only the velocity anomaly as a predictor, but a combination of many precursors. Obviously, much work remains.

It takes money. Perhaps an even bigger problem is the financial one. It does no good to understand dilatancy if you don't know when it's happening underground. To predict quakes properly, we'd have to string seismometers, tilt meters, and other instruments over all high-risk areas and feed the information into large computer systems for constant analysis. That kind of effort takes money—hundreds of millions.

Finally, there is the social problem. What would we do if seismologists were sure a major quake was about to hit San Francisco, say, or Los Angeles? If we knew it to the day or week, whole areas could be evacuated. If we knew it would hit within a year or two, unsafe buildings could be strengthened. In some parts of California, voters have turned down bond issues to strengthen schools that are known to be unsafe in a major quake. But if a quake were known to be coming, the vote might be different.

In the other corner. As in any other human endeavor, there is also bound to be opposition. Real-estate dealers have opposed suggestions that purchasers of homes in potential quake areas should be given such information before they buy. And such sentiments aren't confined to this country. When the Japanese forecast the Maturashira quake several years ago, "those engaged in the sightseeing and hotel business were not really pleased," recalls team leader Rikitake.

But work has begun on this aspect of the problem, too. Social scientists are now working with geophysicists to try to decide how earthquake warnings should be disseminated to the public and what official action would be appropriate.

Thus progress is being made on both fronts—predicting earthquakes and making proper use of the predictions. That in itself may be something of a novelty. "It will be a refreshing change from past performance in other technological developments," says Dr. Carl Kisslinger of the University of Colorado, "if by the time we are ready to make prediction an operational procedure, we're prepared to use it wisely." ■

Home-Office Cube

[Continued from page 108]

Note that the top of the shelf unit is added last, fitted to line up with the rest of the cabinet when the unit is in its down position. Drill countersunk pilot holes through the top, then flip it over and apply its white laminate underface. Now glue and screw the top in place and add the wood-grain laminate to the upper surface. (The front edge of the top gets a laminate facing, but the side edges will be covered with molding).

Sliding top. Drawer-slide hardware similar to that used on the shelf unit—but extra-long—would be ideal for the sliding top; but it just isn't available. Using a pair of the 22" slides (longest made) works out, though, in conjunction with extension tracks of wood strips, to overcome a leverage problem. The two inner track sections are mounted on the frame members of the cabinet, with two 3/8" strips added to provide necessary clearance above the projecting right side wall. Two additional strips of the same thickness flank the single ones to maintain the same level on the left side of the cabinet top. These double extensions (surfaced with nylon tape) prevent the sliding top from tipping downward when it's moved to the left: The bottom edges of the outer track—smoothed with an oil-stone—simply glide over the nylon, supported throughout travel.

To complete this installation, add a small block of wood with a tack glide atop it, centered near the left end of the cabinet top. This prevents any give at that end of the top when it's in the closed position.

Basic construction. Components of the desk are simple to make, but take extra care to get square, true cuts on all plywood parts because out-of-square assembly would prevent proper fit of sliding elements. Tack-nail all parts for the main carcass together before glue-up. Apply glue to both butting surfaces and use 2" finishing nails to hold fast after applying bar clamps. If you don't have such clamps, you must use 2" FH screws (countersunk) to pull all joints together.

Dimensions given on our plans are for the wood assembly; the 1/32" laminate buildup isn't included. Work on the lift-up shelving only after the main carcass has been assembled. Don't attempt to make the shelf unit fill its recess fully: We've dimensioned it a bit undersize to allow some leeway. Final fitting of the track is done with the shim washers. The resulting standoff of the inner track serves another purpose—it pre-

vents the edges of the outer track from scraping against the finish surface of the unit. Where you don't introduce any standoff you may want to file down these sharp edges.

Formica facing. The thin laminate score-cuts easily with a scratch awl. Make several passes along a firmly clamped straightedge, then bend up to snap. Lay out the facing so the grain pattern is matched for adjoining pieces. Apply masking-tape labels to prevent mixups. Allow at least 1/8" projection at all sides. I used Formica contact cement type 160—a nonflammable latex-base formula that grips well and cleans up with soap and water. Coat both surfaces and let set about 30 minutes before pressing into place.

Treat edges first, trimming projections flush with a straight edging bit in your router or laminate trimmer. Larger panels call for the slip-sheet method shown in a photo, to avoid misalignment (once cement-coated surfaces make contact, no adjustment is possible). Cover the cemented surface with two sheets of kraft paper, lapping them near the center. Position the panel precisely, then lift one end and slip out the first sheet to permit contact. Pull out the remaining sheet and complete the bond with a thorough hammering, using a scrap block.

Final corners of the laminate must be routed to a slight bevel (be sure to check the setting of your tool on a test piece). When the entire desk has been surfaced, make some dummy drawer-joint lines on the sides and across the front panel, using a circular saw equipped with a fine-tooth blade set to cut 1/8" deep.

Molding trim. I chose two sizes of a ready-made Waddell molding, and finished each mitered length before attaching (satin-finish brown latex paint with some added lamp-black gives a good contrast to the teak). I tested many glues for attaching the strips to the laminate; all failed but Scotch Super Strength adhesive by 3M. A small tube was enough for the whole job; don't overdo—run a bead on the back that's sized so none oozes out. Press gently into place to transfer some adhesive, then pull the molding back slightly for 20 seconds to permit air drying, and return it for final contact. Secure with strips of tape.

You adapt the file compartment to hold file folders by simply stapling the ends of a folder frame to the front and rear walls. The side rails are then cut to fit. The frames are stock items at stationery stores. ■



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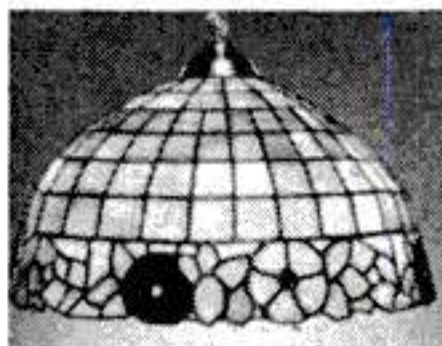
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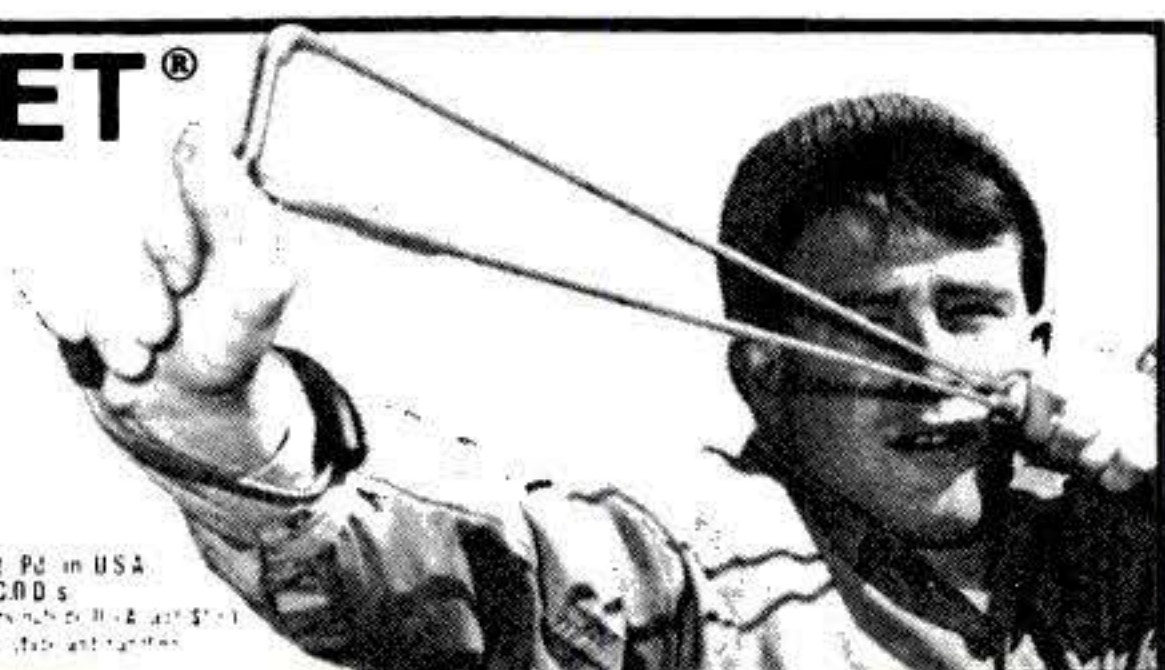
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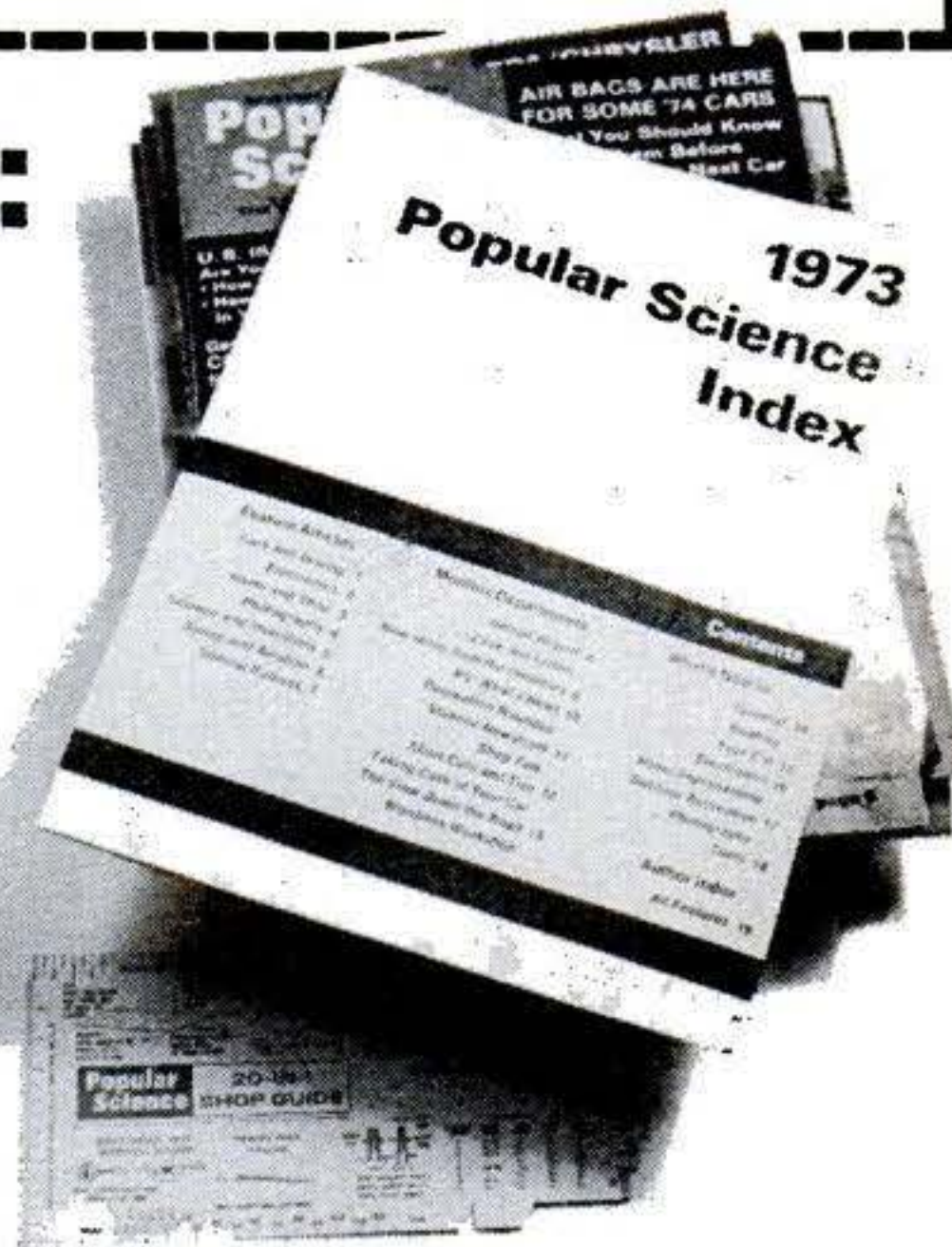
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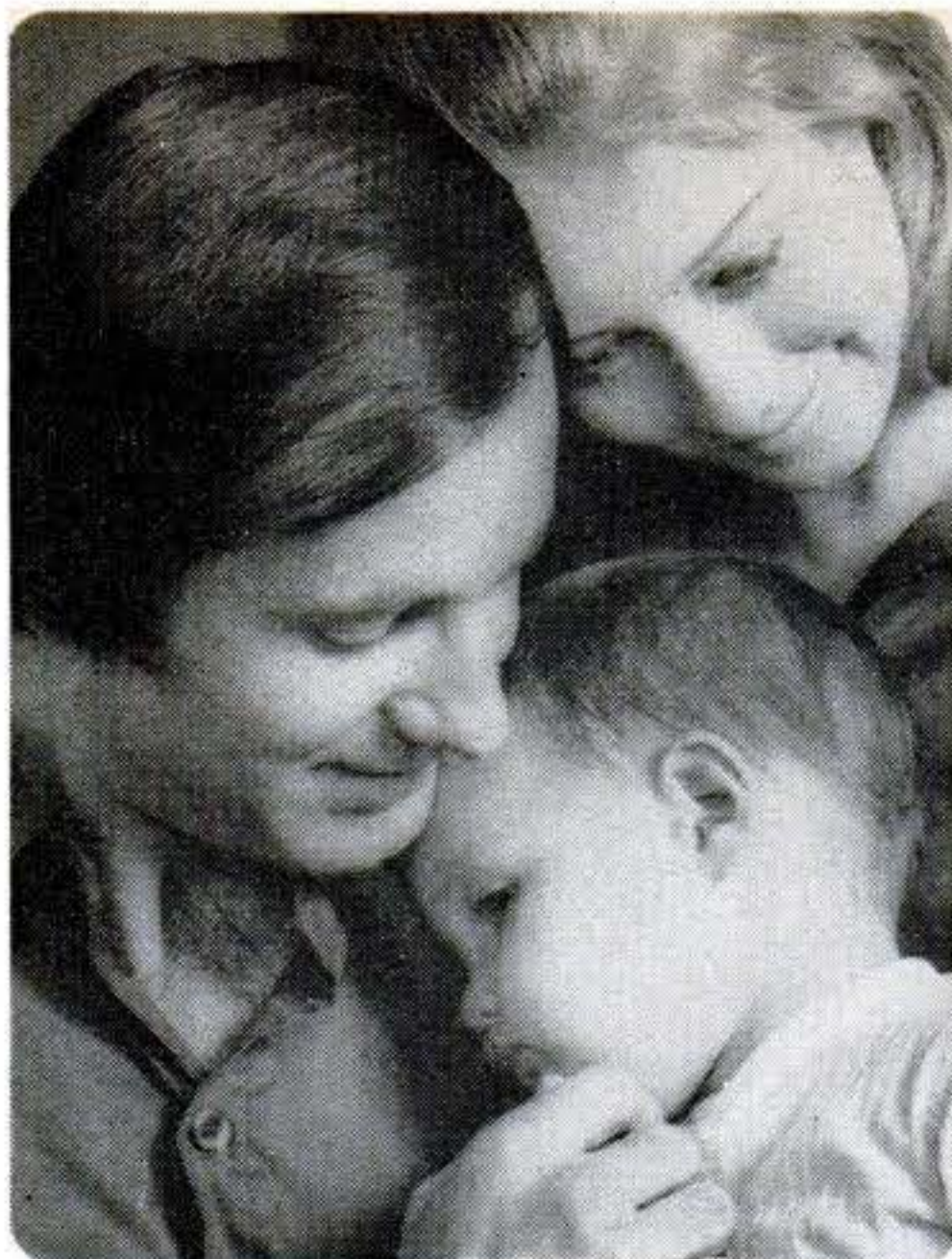
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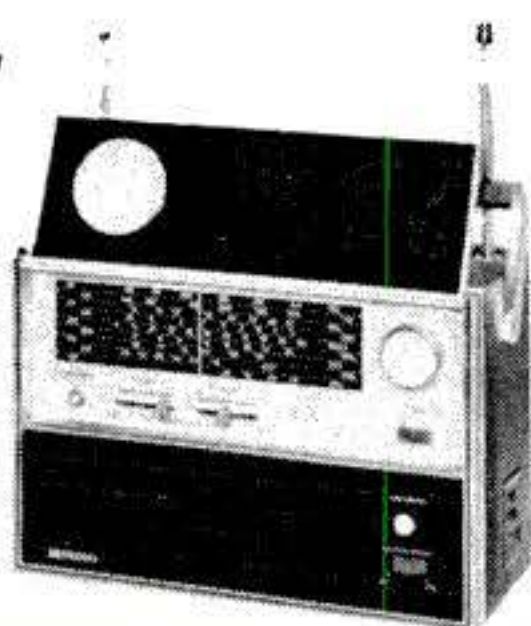
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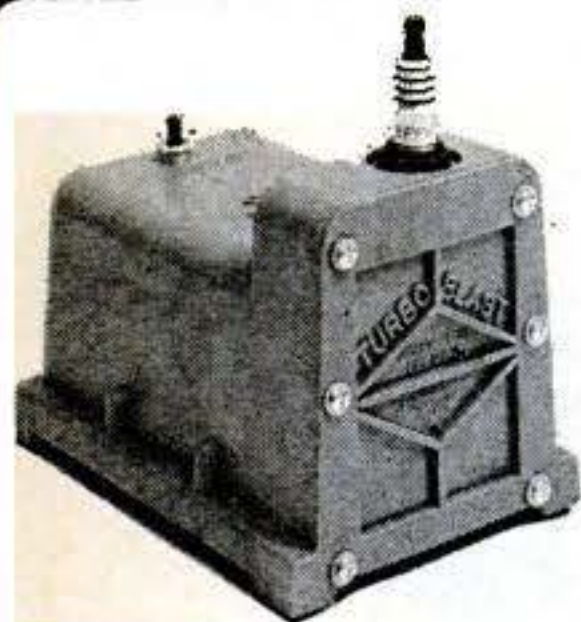
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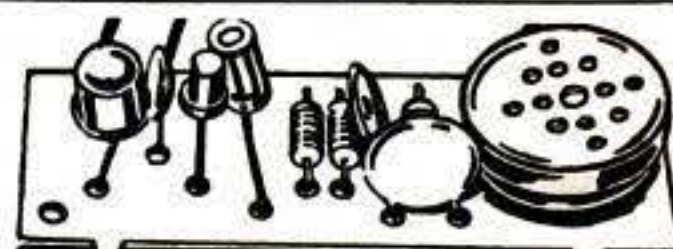
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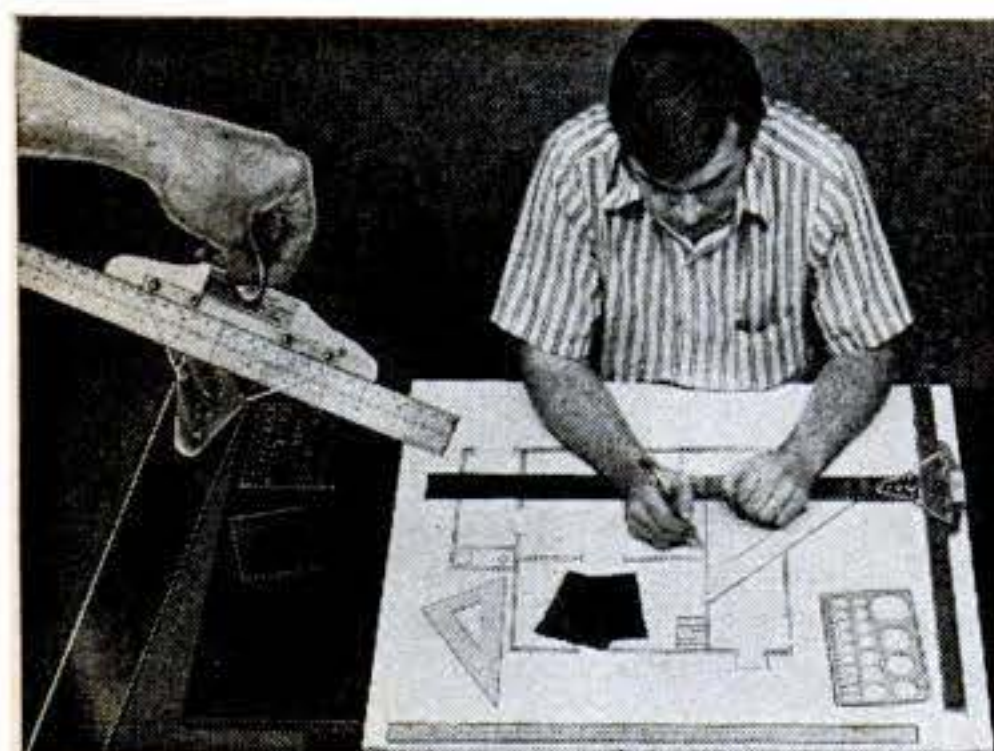
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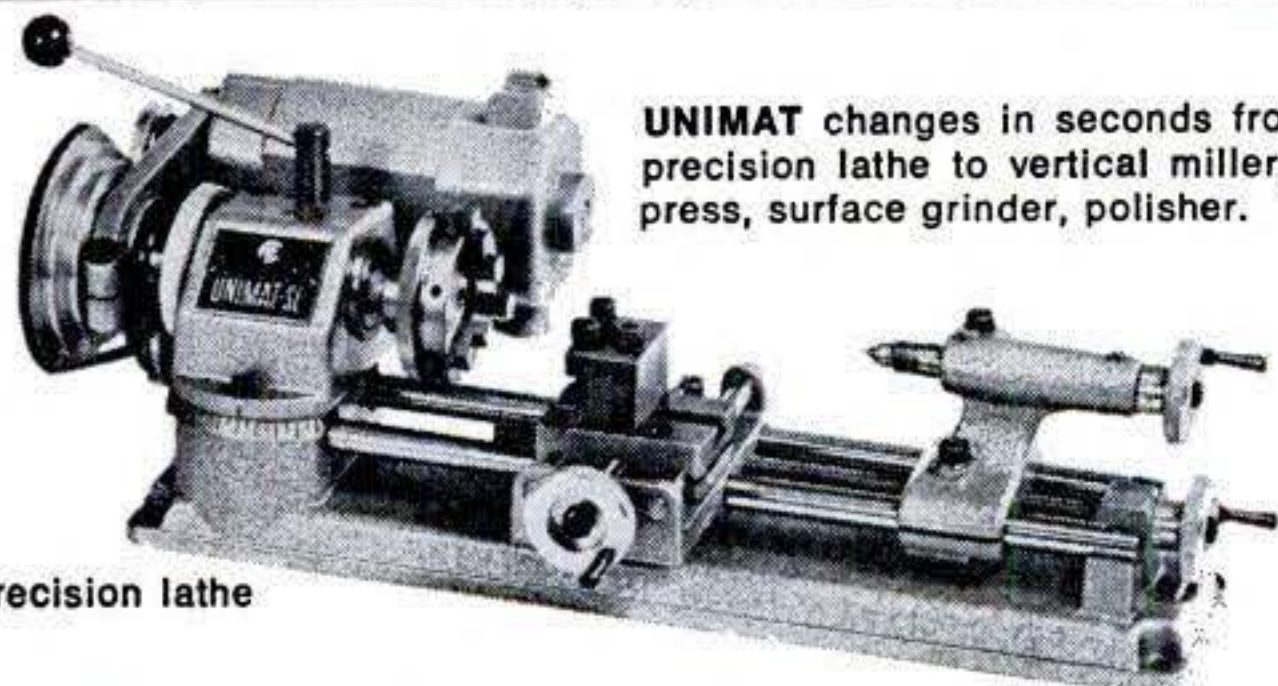
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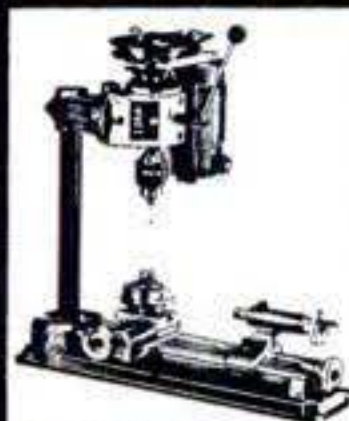
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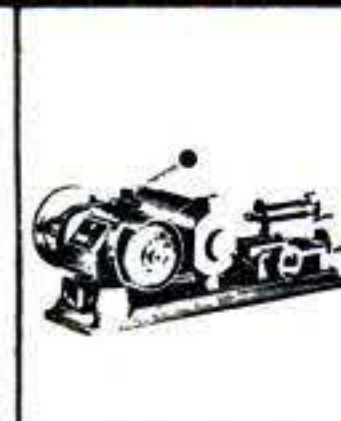
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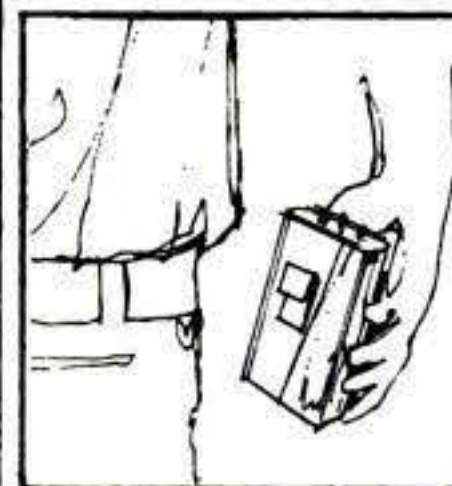
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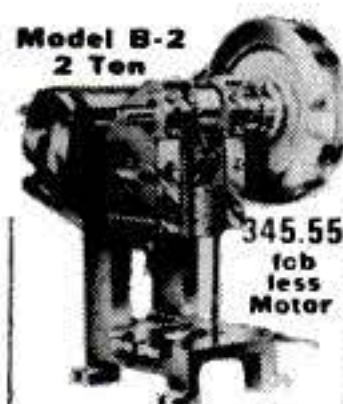
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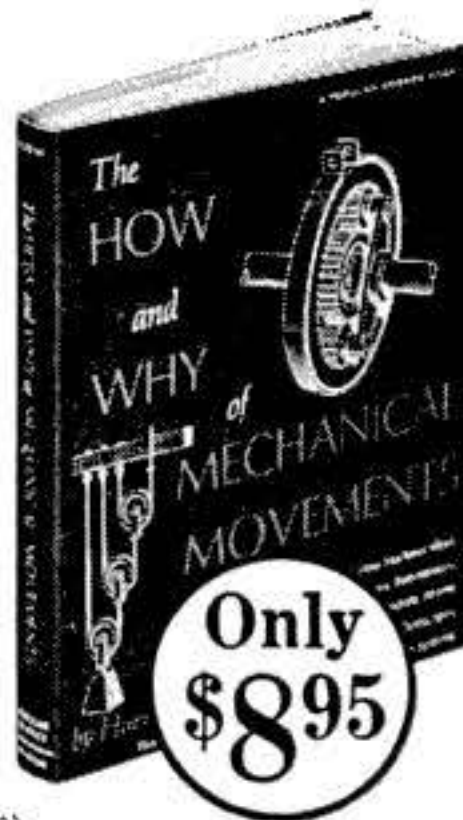
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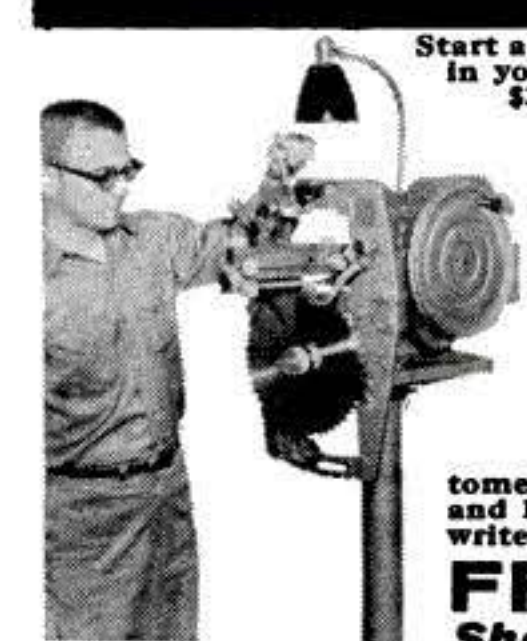
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3. Frequency of Issue: Monthly
4. Location of known office of publication: 380 Madison Avenue, New York, New York 10017
5. Location of the headquarters or general business offices of the publishers: 380 Madison Avenue, New York, New York 10017
6. Names and addresses of Publisher, Editor and Managing Editor: Publisher, J. Michael Hadley, 380 Madison Avenue, New York, N.Y. 10017; Editor, Hubert P. Lockett, 380 Madison Avenue, New York, N.Y. 10017; Managing Editor, Kendall W. Goodwyn, 380 Madison Avenue, New York, N.Y. 10017

7. Owner: Times Mirror Magazines, Inc., 380 Madison Avenue, New York, N.Y. 10017; The Times Mirror Company, Times Mirror Square, Los Angeles, California 90053

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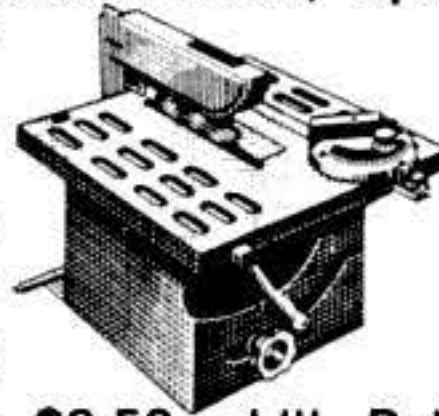
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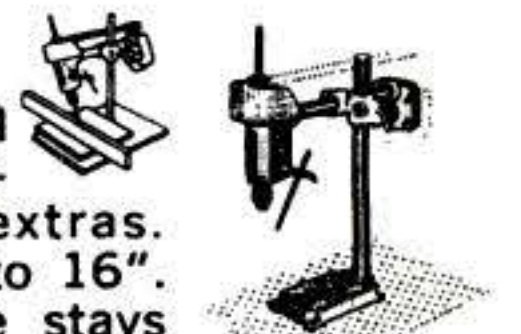
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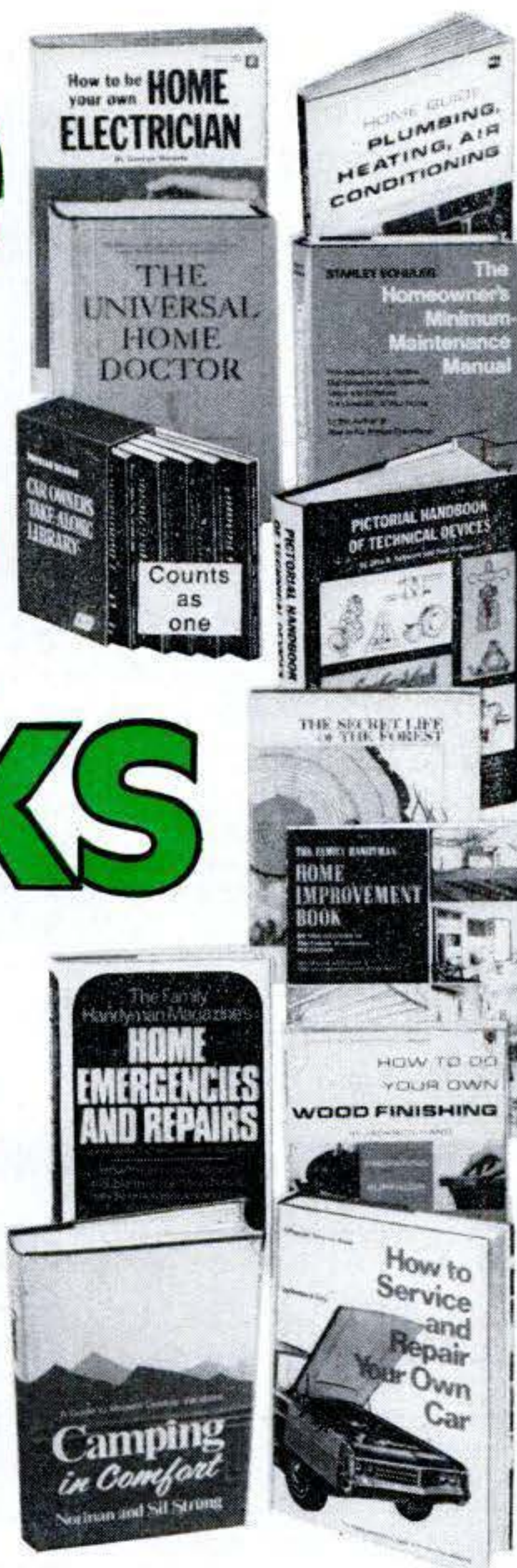
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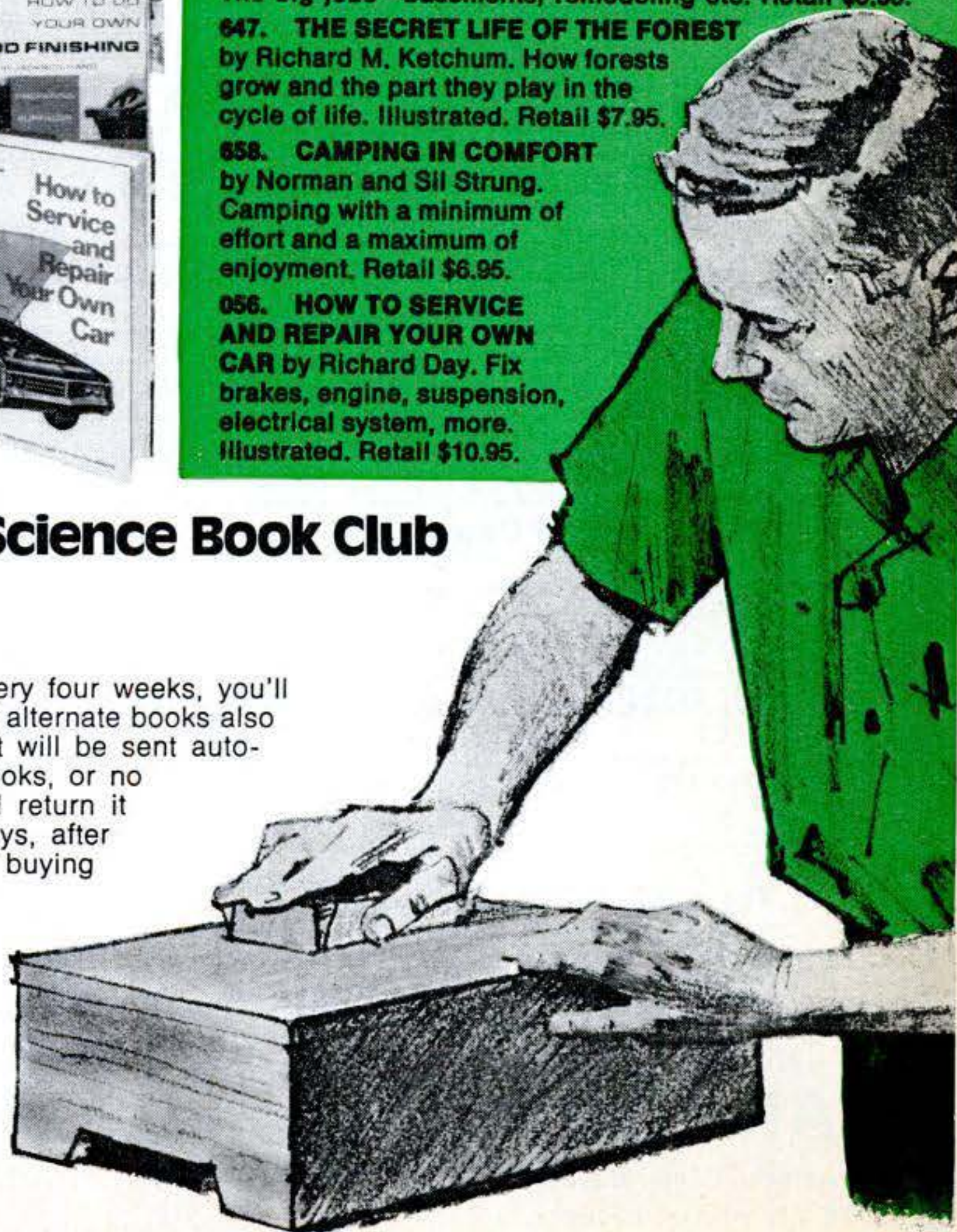
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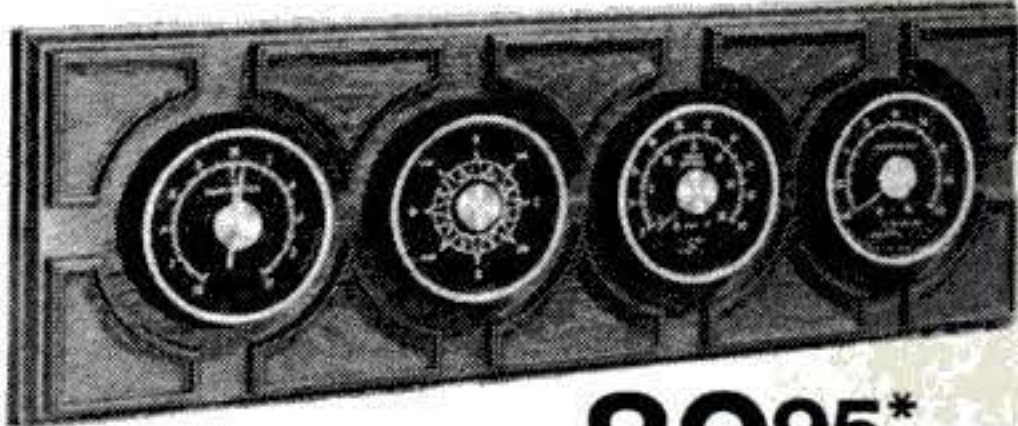
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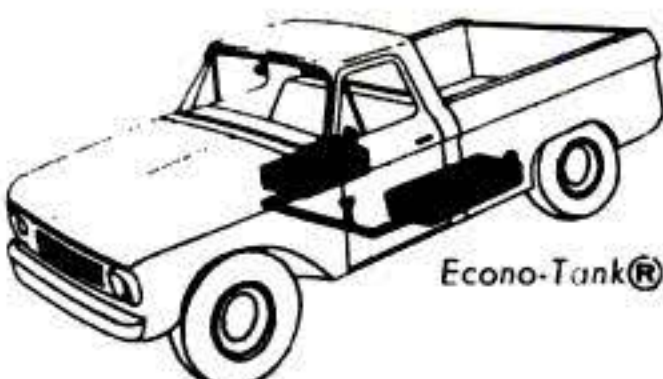
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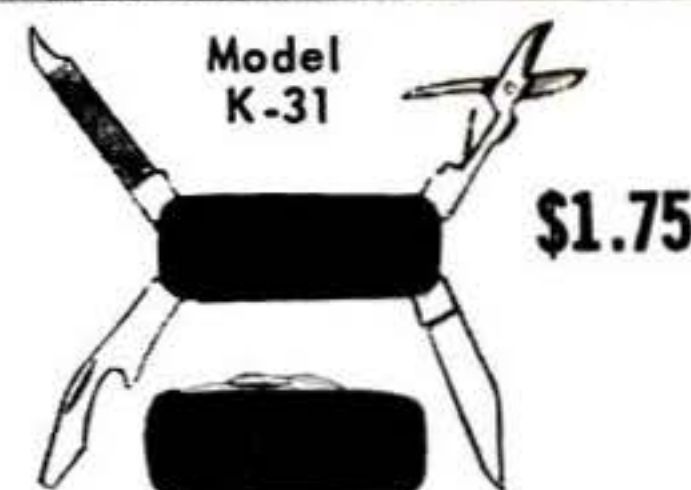
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2 Even the standard cab gives you the solid comfort of a full-foam seat 7 inches deep.

3 You can choose a Ford Six or, for heavy loads, V-8's up to 460 cu. in.



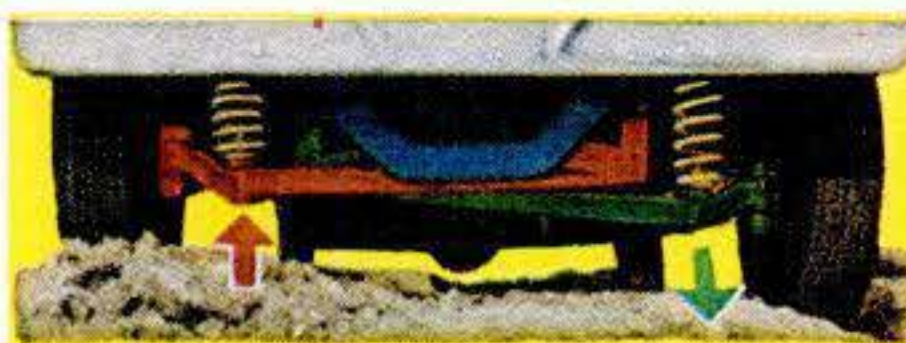
4 Optional air conditioning is built right into the instrument panel for good air circulation, full legroom.

5 Ford pickups come as big as 10,000 lbs. GVW to meet all your pickup truck needs.

6 Sides of the cargo box are double-wall their full depth. All told, over 200 sq. ft. of surface is zinc-coated to resist rust.



7 Behind the seat is a hidden storage space 5½ feet wide. It's big enough to hold tool boxes, golf bags or other gear.



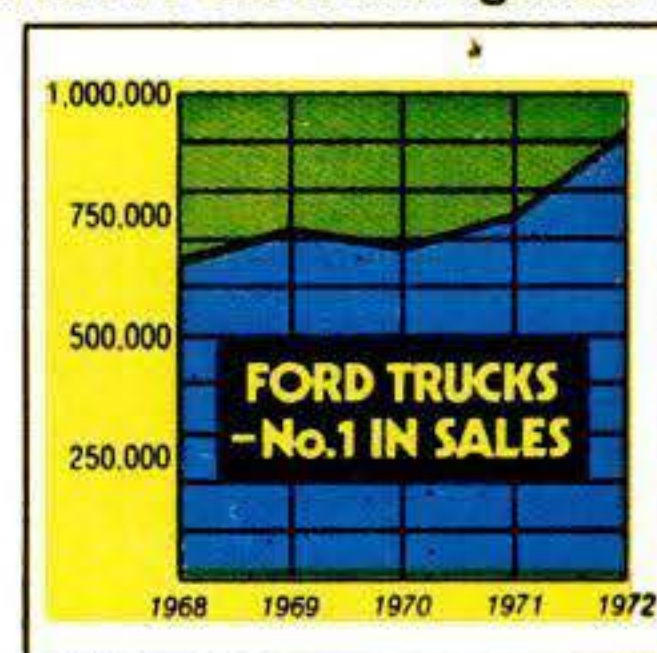
8 Only Ford pickups have Twin-I-Beam suspension for truck strength, carlike ride.

9 Ford took the gas tank out of the cab and put it in a protected position under the box, between the frame rails.



10 Front disc brakes are standard on all '74 Ford pickups with 2-wheel drive.

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